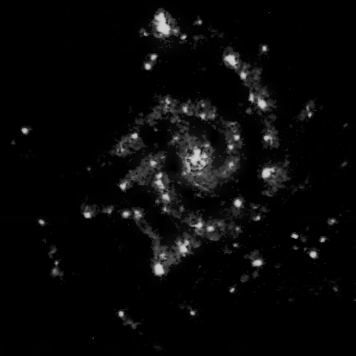
Scientific and Technical Aerospace Reports



An Abstract Journal

Volume 31, Number 10
October 1993
N93-26605 to N93-28463

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An Index Section
- Subject
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- Contract number
- Report number.

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Includes cosmic radiation; and inner and outer earth's radiation belts. For biological effects of radiation see *52 Aerospace Medicine.* For theory see *73 Nuclear and High-Energy Physics.*

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Includes aeronautical, astronautical, and space science related histories, biographies, and pertinent reports too broad for categorization; histories or broad overviews of NASA programs.

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TYPICAL CITATION AND ABSTRACT

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ACCESSION NUMBER → **N93-10068*#** Washington Univ., Seattle. Dept. of Atmospheric Sciences. ← CORPORATE SOURCE

TITLE → **AIR-SEA INTERACTION AND REMOTE SENSING Status Report, 1 Dec. 1991 - 30 Nov. 1992**

AUTHORS → Kristina B. Katsaros and Serhad S. Ataktuerk 1992 ← PUBLICATION DATE

12 p Original contains color illustrations

CONTRACT OR GRANT → (Grant NAGw-1322)

REPORT NUMBERS → (NASA-CR-190913; NAS 1.26:190913) Avail: CASI HC A03/MF A01; 2 functional color pages ← AVAILABILITY SOURCE AND PRICE CODE

The first part of the proposed research was a joint effort between our group and the Applied Physics Laboratory (APL), University of Washington. Our own research goal is to investigate the relation between the air-sea exchange processes and the sea state over the open ocean and to compare these findings with our previous results obtained over a small body of water namely, Lake Washington. The goals of the APL researchers are to study (1) the infrared sea surface temperature (SST) signature of breaking waves and surface slicks, and (2) microwave and acoustic scattering from water surface. The task of our group in this joint effort is to conduct measurements of surface fluxes (of momentum, sensible heat, and water vapor) and atmospheric radiation (longwave and shortwave) to achieve our research goal as well as to provide crucial complementary data for the APL studies. The progress of the project is summarized. Author

VOLUME 31 NUMBER 10 / October 1993

Scientific and Technical Aerospace Reports

A Monthly Publication of the National Aeronautics and Space Administration

01 AERONAUTICS (GENERAL)

N93-27056# Air Force Inst. of Tech., Wright-Patterson AFB, OH.
AVIATION PRODUCTION ENGINEERING: SELECTED ARTICLES
4 Feb. 1993 34 p Transl. into ENGLISH from unknown source (China), no. 102, Jun. 1991 p 25-31
(AD-A261231; FASTC-ID(RS)T-0626-92) Avail: CASI HC A03/MF A01

This article describes the guiding principles of management procedures and staffing of the Xian Aircraft Company Institute of Manufacturing Technology Research. The major role it plays in converting scientific and technical research achievements into productive forces are also presented. DTIC

N93-27166 Israel Society of Aeronautics and Astronautics, Tel Aviv.
COLLECTION OF PAPERS OF THE 31ST ISRAEL ANNUAL CONFERENCE ON AVIATION AND ASTRONAUTICS
20 Feb. 1992 503 p Conference held in Tel-Aviv, Israel, February 18-20, 1992 Sponsored by Technion - Israel Inst. of Tech.; Tel-Aviv Univ.; Ben Gurion Univ. of the Negev; Rafael Armament Development Authority; National Committee for Space Research; Israel Space Agency; Israel Aircraft Industries Ltd.; El Al Israel Airlines Ltd.; Israel Military Industries; Society of Aerospace Engineers in Israel; and S. Neaman Inst. for Advanced Studies in Science and Technology
(ITN-93-85187) Copyright Avail: Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel

Subjects covered by the 56 papers include: hypersonics and advanced aircraft design; control systems design and evaluation; aircraft and spacecraft navigation; rocket ramjet and turbine engine design and development; development, evaluation and applications of synthetic materials; design and construction of space structures; missile guidance, control and avoidance; spacecraft, aircraft and missile propulsion; guidance systems; and aerodynamics. For individual titles, see N93-27167 through N93-27222.

N93-27167 Princeton Univ., NJ. Dept. of Mechanical and Aerospace Engineering.
HYPERSONICS REVISITED **c02**
Seymour M. Bogdonoff *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 1-9 (For primary document see N93-27166 10-01)
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A brief review of the first era of hypersonics is followed by a discussion of the present status of the field. The challenges of the future in hypersonics are outlined, as well as the integrated efforts required for practical solutions. ISA

N93-27168 Lockheed Advanced Development Co., Sunland, CA.
THE DEVELOPMENT OF AIRCRAFT IN THE LOCKHEED SKUNK WORKS FROM 1954 TO 1991 **c05**
Ben R. Rich *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 10-14 (For primary document see N93-27166 10-01)
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Some past projects of the Lockheed Advanced Development Co are briefly reviewed. Among successful programs have been the U-2 and SR-71 series of reconnaissance aircraft, the F-117 stealthy attack aircraft and the YF-22 fighter prototype. The success of the company depends on close cooperation between designers and constructors through all stages of a project. ISA

N93-27169 General Dynamics Corp., Fort Worth, TX.
AVIONICS SYSTEMS ARCHITECTURES **c06**
James D. Engelland *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 15-25 (For primary document see N93-27166 10-01)
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This paper looks at some underlying concepts of architecture in digital avionics systems, discusses how and why these have changed, where we are today in avionics systems integration technology, and introduces some of the issues and considerations associated with next generation systems. The paper includes discussion of centralized versus distributed systems, architectural concepts for growth, structuring for graceful element failures, and system wide integrity concepts. It also takes a brief look at the impact of the new U.S. Air Force Avionics Integrity Program requirements and the Joint Integrated Avionics Working Group standards on architecture and functional partitioning. ISA

N93-27170 Tel-Aviv Univ. (Israel). Faculty of Exact Sciences.
SPURIOUS FREQUENCIES AS A RESULT OF NUMERICAL BOUNDARY TREATMENTS **c34**
S. Abarbanel *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 26-29 (For primary document see N93-27166 10-01)
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Historically, CFD (computational fluid dynamics) methodologies have been used mostly to tackle aerodynamic problems that possess steady state solutions. More recently, however, the increases in computer speed and memory have allowed researchers to investigate fluid dynamical problems with greater attention to the more delicate details of the flow. Thus, one can now not only compute the pressure distribution on an airfoil (or cylinder) but also, for example, study the temporal problem of vortex shedding by such a body. It has previously been shown that a legitimate (i.e., stable) statement of physical and numerical far-field boundary conditions may lead to spurious oscillations not connected to the vortex shedding and that they may even overshadow the physical processes in the flow. We discuss the reasons for this state of affairs and ways to correct the situation, and speculate about what might await us in the case of truly time-periodic excitations of the flow, such as caused by aileron buzz, incipient flutter, etc. ISA

N93-27171 California Univ., Los Angeles. Dept. of Mechanical, Aerospace and Nuclear Engineering.
GAME THEORETIC SYNTHESIS FOR ROBUST AEROSPACE CONTROLLERS **c08**
Jason L. Speyer *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 31-41 (For primary document see N93-27166 10-01)
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A synthesis method is described and illustrated for the design of

feedback controllers in the presence of plant and measurement disturbances and parameter uncertainty. The synthesis method involves a state space description in which the system disturbances and uncertainties are embedded in the system model. Furthermore, the cost criterion is a disturbance attenuation function composed of the ratio of the quadratic norm of certain outputs to the input disturbances. The outputs are chosen so that both desirable performance and stability robustness are obtained. The problem of finding the controller which minimizes the attenuation function in the presence of the worst disturbances is equivalent to a linear-quadratic game problem. The result is a linear controller whose gains are determined from two algebraic Riccati equations. This compensator is illustrated by three examples. The first, representing the control of a two-mass system, is used to motivate the approach to controller design. However, when viewed as a simple model of a flexible structure, the problem is interesting and challenging, leading to a nonminimal phase compensator. The second example, which illustrates an important control problem with full state feedback, is that of controlling attitude or attitude rate as well as momentum of the space station. Finally, a VSTOL aircraft at a transition velocity illustrates the partial information case. ISA

N93-27172 Harvard Univ., Cambridge, MA. Division of Applied Sciences.
FRACTURE MICROMECHANICS OF CERAMIC COMPOSITES Abstract Only **c24**

Bernard Budiansky *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 42 (For primary document see N93-27166 10-01)

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Development of reinforced ceramics aims to combine the high-temperature tolerance of ceramics with improved fracture resistance. Proposed reinforcements comprise strong ceramic fibers or whiskers, ductile particles and phase-transforming materials. The primary toughening mechanism induced by fibers and ductile particles is crack bridging, in which crack propagation is inhibited by the presence of intact fibers or particles which span the opposing faces of a crack, tending to prevent their separation. In the case of phase-transforming particles (of which zirconia, ZrO2 is the only one used so far), the high stresses near an advancing crack tip cause the particles to change phase, expand in size and thereby tend to close the crack. Micromechanical modeling of these processes illuminates the roles of the various physical parameters involved, such as interface friction, particle or fiber size, residual stress; it also provides quantitative estimates of the toughening effect; and it provides a rational guide to material development and design. ISA

N93-27173 Lockheed Advanced Development Co., Burbank, CA.
YF-22A PROTOTYPE ADVANCED TACTICAL FIGHTER DEMONSTRATION/VALIDATION FLIGHT TEST PROGRAM OVERVIEW **c05**

David L. Ferguson *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 43-56 (For primary document see N93-27166 10-01)

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The Lockheed Aeronautical Systems Company, teamed with the General Dynamics Fort Worth Division and Boeing Military Airplanes Company, designed, built and flight tested two YF-22A Advanced Tactical Fighter (ATF) prototypes which were powered by new prototype high-thrust-to-weight ratio engines. The YF-22A design optimized the blend of low observability, maneuverability and supersonic performance. These design goals were achieved with the incorporation of many new and innovative technologies, including thrust vectoring, integrated flight and propulsion control, internal weapons carriage, and composite materials. An advanced cockpit with colored liquid crystal displays, finger-on-glass controls and advanced avionics architecture was also incorporated in the prototypes. The YF-22A Demonstration/Validation (Dem/Val) flight test program was completed on the 28th of December 1990. Seventy-four flights for a total of 91.6 flight hours were accumulated on both prototypes. The first flight of YF-22A no. 1 was made on 29 September 1990; the second prototype flew on 30 October 1990. The primary objective of the Dem/Val flight test program was to demonstrate the airplane's capabilities. This approach, which prioritized the use of the aircraft as demonstrators over their use as development tools, was considered to be the most efficient method of generating the test data required for the Engineering and Manufacturing Development (EMD) proposal. The purpose of this paper is briefly to describe some of the YF-22A's unique design features and flight instruments. ISA

N93-27174 European Space Agency, Paris (France).
EUROPEAN SPACE PROGRAMME Abstract Only **c12**

J.-M. Luton *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 56A-56B (For primary document see N93-27166 10-01)

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Successful European Space Agency (ESA) programs include the Ariane launcher development, the Meteosat meteorological satellites and the Intelsat 6, ECS (European Communications Satellite) series of communications satellites. The ESA's policy of placing contracts with industrial companies in its 13 member countries has contributed to the strategic development of European high technology in the world market. The ESA's long-term programs, in addition to the Ariane launcher and Columbus/Hermes space-station/spaceplane programs, include participation in the International Space Station program, the Data Relay Satellite system and a variety of space applications programs. Two high-performance satellites to be placed in polar orbits will contribute to European environmental and climate variation studies and, together with the Polar Platform sector of the Columbus program, will drive the establishment and development of new institutions, industrial structures and infrastructure. ISA

N93-27175 Princeton Univ., NJ. Dept. of Mechanical and Aerospace Engineering.
AEROSPACE APPLICATIONS OF METAL COMBUSTION **c25**

Irvin Glassman *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 57-64 (For primary document see N93-27166 10-01)

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Various aspects of metal combustion in aerospace applications are discussed. The choice of metals to increase solid rocket performance is analyzed on a purely thermodynamic basis. The thermophysical properties of metals and their oxides are shown to predict which metal would burn efficiently in propulsive devices. Pyrophoric metal addition to hydrogen fuels is suggested to facilitate ignition, mixing and radical recombination under supersonic combustion conditions found in hypersonic flight. Lastly, the creation of high temperature refractory and intermetallic materials for aerospace usage by novel metal combustion techniques is described. ISA

N93-27176 Israel Aircraft Industries Ltd., Beer-Yaaqov. Aeromechanical Dept.
CRYOGENIC TRANSFER MODULE FOR GEOSYNCHRONOUS ORBIT **c18**

Claude Oiknine *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 65-77 (For primary document see N93-27166 10-01)

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Israel Aircraft Industries (IAI) is developing a Cryogenic Transfer Module (CTM) which will be able to raise a 2,100-kg satellite from low earth orbit to geosynchronous earth orbit. The CTM is fully independent of the satellite payload during the entire transfer mission, which can last about 10 days. It is powered by a cryogenic propulsion unit of 10,000-N thrust, using liquid oxygen and liquid hydrogen. Total burn time is 2,100 seconds, typically divided into five discrete burns at perigee and apogee. The stage mass fraction is 0.87, with a maximum cryogenic propellant mass of 4,800 kg. Ground tests of the propulsion unit have been started. ISA

N93-27177 Technion - Israel Inst. of Tech., Haifa. Faculty of Aerospace Engineering.
VISUAL FIELD INFORMATION IN NAP-OF-THE-EARTH FLIGHT BY TELEOPERATED HELMET-MOUNTED DISPLAYS **c54**

Arthur J. Grunwald, S. Kohn, and S. J. Merhav *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 78-97 (For primary document see N93-27166 10-01)

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The human ability to derive control-oriented visual field information from teleoperated helmet-mounted displays in nap-of-the-earth flight is investigated. The visual field with these types of display originates from a forward-looking infrared radiation camera, gimbal-mounted at the front of the aircraft and slaved to the pilot's line-of-sight, to obtain wide-angle coverage. Although these displays are proved to be effective in Apache and Cobra helicopter night operations, they demand very high pilot proficiency and work load. Experimental work presented in this paper has shown that part of the difficulties encountered in vehicular control by means of these displays can be attributed to the narrow viewing aperture and head/camera slaving system phase lags. Both of these shortcomings will impair visuo-vestibular coordination when voluntary head rotation is present. This might result in errors in estimating the control-oriented visual field information vital in vehicular control, such as the vehicle yaw rate or the anticipated flight path, or might even lead to visuo-vestibular conflicts (motion sickness). Since, under these conditions, the pilot will tend to minimize head rotation, the full wide-angle coverage of the helmet-mounted display, provided by the line-of-sight slaving system is not always fully utilized. ISA

N93-27178 Rafael Armament Development Authority, Haifa (Israel).
INFORMATION-BASED CRITERIA OF TERRAIN NAVIGABILITY. PART 1: DATA-BASE ANALYSIS **c04**
S. Faibish and A. Yavnai *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 98-106 (For primary document see N93-27166 10-01)
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A novel approach for terrain-aided navigability analysis is presented. This approach is based on evaluating the information content of the terrain spatial spectra, as related to the problem of minimizing the location error, given a pattern of terrain elevations. A set of information theoretic criteria has been developed and used. The criteria developed have been found to be a useful tool for navigability analysis and for optimal (in the sense of minimum navigation error) route planning. It is shown that the greater the spatial variance, the lower the entropy and the higher the navigability of the terrain. Part 1 of the work concentrates on terrain data-base analysis. ISA

N93-27179 Technion - Israel Inst. of Tech., Haifa. Faculty of Aerospace Engineering.
MERGING SPARSE OPTICAL FLOW AND EDGE CONNECTIVITY BETWEEN IMAGE FEATURES: A REPRESENTATION SCHEME FOR 2-D DISPLAY OF SCENE DEPTH **c43**
J. Waldmann and S. J. Merhav *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 107-115 (For primary document see N93-27166 10-01)
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A representation scheme for sparse depth maps which supports 3-D interpretation is developed. The sparse depth map is obtained by combining the optical flow with noisy measurements of the motion parameters. An edge-connectivity digraph is built with its nodes mapping image features. The edge connectivity in the image is mapped into the digraph connectivity. A depth-parameterized grammar has been created to generate strings from the digraph. This model copes with images of unstructured surroundings which cannot be easily dealt with by object modelling and matching techniques. Connected nodes with similar depth attributes are clustered into strings that correspond to distinct edges in the image, using data at pixel level. The scheme was tested on blurred synthetic images of house-shaped obstacles. The spatial distribution of the resulting edges closely approximates the actual 3-D contour of the obstacles, with occlusions successfully resolved. The resulting 3-D connectivity can be used to augment a coarse-resolution terrain database with the purpose of automated obstacle avoidance during nap-of-the-earth flight. ISA

N93-27180 Regional Engineering Coll., Kerala (India). Dept. of Electrical Engineering.
NEW ADAPTIVE CONTROLLERS FOR AIRCRAFT **c63**
F. Gajendran *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 116-127 (For primary document see N93-27166 10-01)
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This investigation is concerned with the model reference adaptive control (MRAC) of the pitch rate of the aircraft. A new adaptive control scheme is proposed and its stability analysis is presented, employing certain novel Liapunov functions. This scheme gives better performance when appropriate measures are taken. ISA

N93-27181 Israel Aircraft Industries Ltd., Tashan.
COMPOSITE LAMINATED BEND ANALYSIS AND EXPERIMENTS **c24**
I. Kressel and T. Gottesman *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 128-135 (For primary document see N93-27166 10-01)
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A closed form analytical solution to the behavior of a composite laminated bend under general end load conditions is derived and verified experimentally. Stress and strain distributions are obtained as a function of the applied loads and bend geometry. C-channel specimens are tested with the bend under dominant bending moment. The measured strains show excellent correlation with the analytical predictions. In the tested case the radial stresses are dominant, depending mainly on the geometry, with negligible effect of the lay-up. All tested bends failed in the same statistical distribution, thus, a design allowable for a specific material system can be defined. ISA

N93-27182 Tel-Aviv Univ. (Israel). Fracture Mechanics Lab.
APPLICATION OF THE CYCLIC J-INTEGRAL TO FATIGUE CRACK PROPAGATION **c39**
Yehuda Volpert and Leslie Banks-Sills *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 136-143 (For primary document see N93-27166 10-01)
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A cyclic J-integral method is investigated considering correlation of fatigue crack growth rate under elastic and small scale yielding conditions. An experimental/numerical study is carried out in order to explain more clearly the meaning of the cyclic J-integral delta J, for fatigue crack growth studies. Compact tension specimens fabricated from Al 2024-T351 were subjected to constant amplitude loading with two R-ratios (R approximately equal to 0.05 and 0.5). A simulation of conducted tests is carried out numerically, employing the finite element method with the material modeled to be elasto-plastic. From the numerical results, values of delta J are calculated from both a path independent integral and load versus load-line displacement data. Comparison between these values, as well as with those determined from experiments are seen to be reasonable. The delta J parameter is seen to correlate properly with the crack growth rate under elastic and small-scale yielding conditions. ISA

N93-27183 Rafael Armament Development Authority, Haifa (Israel). Materials and Processes Dept.
EPOXY ADHESIVES FOR FIELD REPAIR OF COMPOSITE STRUCTURES **c27**
H. Dodium and S. Kenig *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 144-148 (For primary document see N93-27166 10-01)
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Repair of composite and metallic structures by structural adhesives, under field conditions, has drawn a great deal of attention in recent years. In addition to elevated service temperature requirements, a relatively low curing temperature and endurance under aggressive environmental conditions (heat and humidity) are of major importance. To meet these requirements, a few epoxy adhesives were formulated and tested. The structural epoxy adhesives comprise selected high functionality aromatic epoxy resins and multicomponent polyamine curing systems containing an elastomeric toughening agent. Experimental results show that selected formulations develop good high temperature (120 C) properties while cured under ambient conditions or moderate temperatures (50-60 C). Both shear and peel strengths of the proposed adhesives were found to be competitive

with elevated temperature curing film adhesives. Glass fabric composites, based on a selected epoxy formulation, exhibited flexural and interlaminar shear strengths, when cured at reduced temperatures, compared with commercial 250 F curing prepregs. ISA

N93-27184 Israel Military Industries, Ramat-Hasharon.
STABILITY OF SINGLE LAYER COMPOSITE CYLINDERS SUBJECTED TO LATERAL PRESSURE: NUMERICAL APPROACH **c39**
M. A. Mikulinsky *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 149-153 (For primary document see N93-27166 10-01)
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The buckling of thin, single-layer composite cylinders with simply supported edges was calculated by means of a simplified analytical solution and verified by means of detailed numerical calculations, using the finite element method. The verification was performed for two sets of cylindrical geometry parameters, three ratios of axial-to-hoop Young's moduli and for a wide range of shear modulus values. The validity of the analytical equations was confirmed by reasonable agreement between the analytical and numerical results; in general, the finite element calculations give higher buckling loads than the simplified analytical equation. ISA

N93-27185 Technion - Israel Inst. of Tech., Haifa. Faculty of Aerospace Engineering.
REGRESSION RATE MECHANISM IN A SOLID FUEL RAMJET **c07**
Ilan Hadar and Alon Gany *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 154-162 (For primary document see N93-27166 10-01)
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A model relating the combustion characteristics, particularly the regression rate, to the fuel properties in a solid fuel ramjet (SFRJ) is presented. The analysis is based on inspecting the various phenomena (e.g., chemical kinetics and heat transfer) involved in the fuel decomposition process, in order to determine the rate controlling steps, and modeling the important mechanisms. Model results were compared with experimental findings for four polymeric fuels, showing excellent qualitative agreement in classifying different fuels, as well as good quantitative predictions of the fuel regression rates. The model can serve as a useful tool for the selection of appropriate fuels, as well as for a preliminary design of the engine and mission profile prior to static firings of the final SFRJ prototype. ISA

N93-27186 Technion - Israel Inst. of Tech., Haifa. Faculty of Aerospace Engineering.
DEVELOPMENT OF A PULSE RAMJET BASED ON TWIN VALVELESS PULSE COMBUSTORS COUPLED TO OPERATE IN ANTIPHASE **c07**
N. Libis and Y. Goldman *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 163-170 (For primary document see N93-27166 10-01)
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The description of a new pulse ramjet engine of unusual configuration, the first experimental results of its operation, and the analytical approach guiding its development are presented. The developed system is based on a coupling of two valveless pulse engines at their common inlet, by a symmetrical pulse ejector. During preliminary laboratory trials, the engine was shown to produce a stagnation pressure rise of about 0.5 atm and a negative induction pressure of about 0.2 atm. The tests also confirm the expected antiphase mode of operation of the two combustion chambers. Kerosene fuel was supplied at rates up to 40 liter per hour per combustion chamber. The method of characteristics is applied for analysis of the nonsteady flow in the inlet and exhaust pipes. Boundary conditions at the duct ends, including the changes in the combustion chamber pressure and temperature are defined. A simple heat release scheme is used to simulate the combustion process. The analytical model is still in the process of development, and only the governing equations and a description of the numerical procedure on which it is based are presented. ISA

N93-27187 Technion - Israel Inst. of Tech., Haifa. Faculty of Aerospace Engineering.
ANALYSIS OF THRUST MODULATION OF RAM-ROCKETS BY A VORTEX VALVE **c07**
Claudio Goldman and Alon Gany *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 171-177 (For primary document see N93-27166 10-01)
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Thrust modulation of a ram-rocket by means of a fluidic vortex valve was analyzed. The controllable parameter was the tangential injection of a secondary flow imposing swirl in the main gas generator flow. An analytical model was developed to predict the swirl effects on the gas generator flow rate and on the engine thrust. The main parameters studied were the propellant burning rate pressure exponent, the nozzle radius ratio, and the vortex type. Model predictions indicated the effectiveness of the vortex valve control method, which allows a 40 to 80 percent thrust increase by the addition of only 10 percent of secondary flow to the main flow. ISA

N93-27188 Prins Maurits Lab. TNO, Rijswijk (Netherlands).
GAS GENERATOR IGNITER PERFORMANCE AT EXTREMELY LOW TEMPERATURES **c20**
G. M. H. J. L. Gadiot *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 178-184 (For primary document see N93-27166 10-01)
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The Ariane 5 launch vehicle is presently being developed by the European Space Agency. Its Vulcain main stage LOX/LH2 (liquid oxygen/liquid hydrogen) engine employs a gas generator cycle that drives the two separate turbopumps for the transport of LOX and LH2 to the combustion chamber. The gas generator is ignited by a pyrogenic igniter (GGI - gas generator ignitor) which utilizes a clean ammonium nitrate/HTPB-type propellant. Ignition of this type of propellant is difficult and in order to study the ignition and performance limits of the device, a test series in which a total of 48 devices were fired was carried out. For the tests, three different propellant batches were employed, using conditioning temperatures ranging from -80 C to +60 C. Special attention was given to batch-to-batch variations of the propellant, helium pressurization, squib location, and squib number. General conclusions are that the GGI generally performs according to specifications with respect to: ignition delay, burning rate vs pressure, action time, mass flow requirement, and maximum casing pressure. The limit for the initial propellant temperature to obtain proper ignition, holding for all batches, was found to be -60 C. ISA

N93-27189 Israel Society of Aeronautics and Astronautics, Tel Aviv.
BY-PASSING OF HEAT EXCHANGERS IN GAS TURBINES **c07**
David Lior *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 185-196 (For primary document see N93-27166 10-01)
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A methodology is presented to optimize the design of a heat-exchanger in a gas turbine. The effect of by-passing a portion of the hot and cold flows around the heat exchanger is explored, considering variation of pressure drops, heat-exchanger efficiencies, and consequently the influence of the by-pass on gas turbine efficiency and power. As a result, it is shown that the by-pass method results in a substantial gain in heat-exchanger size with only minor sacrifice in performance. A variable by-pass ratio to match the load profile of the gas turbine is shown as the best system optimization. A methodology is presented to derive the optimum relation between load and by-pass ratio. ISA

N93-27190 Cornell Univ., Ithaca, NY. National Supercomputer Facility.
PARALLEL COMPUTING STRATEGIES FOR BLOCK MULTIGRID IMPLICIT SOLUTION OF THE EULER EQUATION **c34**
Yoram Yadlin and David A. Caughey *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 197-206 (For primary document see N93-27166 10-01)
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A multigrid diagonal implicit algorithm was developed to solve the three-dimensional Euler equations of inviscid compressible flow on Block Structured grids. An improved method of advancing the multigrid cycle was examined with respect to convergence rates, accuracy, and efficiency. In this method, the multigrid cycle is advanced independently in each of the blocks, and the information exchange between the blocks is done by using buffer arrays, allowing for the asynchronous updating of interface boundary conditions. This updating scheme is used to eliminate convergence problems found in a previous implementation of the algorithm, while retaining its potential for efficient parallel execution. Results are computed for transonic flows past wings, and include pressure distributions to verify the accuracy of the scheme, and convergence histories to demonstrate the efficiency of the method. Efficiencies which were obtained using a modest number of processors in parallel are also presented and discussed. ISA

N93-27191 Technion - Israel Inst. of Tech., Haifa. Faculty of Aerospace Engineering.

AN EFFICIENT SOLUTION PROCEDURE FOR THE THERMOELASTIC ANALYSIS OF TRUSS SPACE STRUCTURES **c18**

D. Givoli and O. Rand *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 207-213 (For primary document see N93-27166 10-01)

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A solution procedure is proposed for the thermal and thermoelastic analysis of truss space structures in periodic motion. In this method, the spatial domain is first discretized using a consistent finite element formulation. Then, the resulting semi-discrete equations in time are solved analytically by using Fourier decomposition. Geometrical symmetry is taken advantage of completely. An algorithm is presented for the calculation of heat flux distribution. The method is demonstrated via a numerical example of a cylindrically shaped space structure. ISA

N93-27192 Technion - Israel Inst. of Tech., Haifa. Faculty of Aerospace Engineering.

PASSIVE DAMPING AUGMENTATION OF FLEXIBLE BEAM-LIKE LATTICE TRUSSES FOR LARGE SPACE STRUCTURES **c18**

K. Cohen and T. Weller *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 214-225 (For primary document see N93-27166 10-01)

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A Timoshenko beam continuum model is developed, to determine the transient response of a beam-like latticed large space structure, subjected to a unit impulse. It is demonstrated that an increase in diagonal stiffness, on account of the stiffness of the vertical girder, leads to a rise in the transverse shear rigidity. This results in higher natural frequencies and reduction in peak displacement. In addition, in an asymmetrical truss configuration, coupling between the extensional and shear modes raises the maximum peak displacement compared with that obtained for a symmetrical truss. The model is modified to investigate the introduction of passive damping in the form of several dynamic vibration absorbers. For simple, yet efficient analysis, a unique absorber parameter optimization procedure, based on the classical steady-state criteria, is used to tune the absorbers, having a total allocated mass budget of 10 percent, to the first two frequencies of the latticed structure. It is found that inclusion of transverse shear rigidity as a design parameter, in damping augmentation studies, reduces settling time for predetermined maximum peak displacements. ISA

N93-27193 Technion - Israel Inst. of Tech., Haifa. Faculty of Aerospace Engineering.

PREDICTION OF PROPELLANT BEHAVIOR IN SPINNING FLOW OF A SPACE MOTOR Abstract Only **c28**

A. Gany, Y. Levy, and Y. M. Timnat *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 226-228 (For primary document see N93-27166 10-01)

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An experimental simulator was built to aid determination of the distribution and trajectories of aluminum/alumina particles resulting from combustion within a spinning high-energy, solid-propellant rocket motor. Laser doppler anemometry was used to obtain data on the velocity and size distributions of injected paraffin droplets. Droplets below 5-micrometer diameter provide gas-flow data while those larger than 20 micrometer simulate the aluminum oxide particles. The pyrex test chamber comprised two end-to-end sections with a step change in diameter; it was rotated by a variable speed motor and air flowed through it axially, carrying droplets which had been injected into the air stream before its entry to the chamber. The droplet velocity/size distribution was measured by means of an optical system based on a 5-W argon ion laser, frequency shifter, and a beam splitter, with an electronic discrimination system to ensure association of velocity and size with the correct particle. Preliminary results indicate that rotation has a negigible effect on the axial velocities while the tangential velocities approximate solid body rotation. ISA

N93-27194 Technion - Israel Inst. of Tech., Haifa. Faculty of Aerospace Engineering.

ENHANCED ORBITAL GYROCOMPASSING BY THE OPTICAL FLOW SENSED BY AN EARTH-POINTING CAMERA **c19**

Leora Topaz and Arthur J. Grunwald *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 229-242 (For primary document see N93-27166 10-01)

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A method for improving the orbital gyrocompassing process involving the attitude angle estimation of an earth pointing satellite in low-earth orbit is described. This estimation process usually employs a discrete, variable-gain Kalman Filter scheme, processing the measurements of roll, pitch, and yaw rate gyros, a horizon sensor, and sometimes a sun sensor. The improved method uses an electro-optical sensor for enhancing the process by direct measurement of the satellite azimuth angle. Simulations showed that this additional measurement drastically reduces the estimator convergence time, in particular when the sun-sensor is ineffective, i.e., at high sun angles. The azimuth-sensing method is based on estimating the image shift between successive picture frames of an on-board CCD (charge-coupled device) full-matrix camera, pointing towards the earth. The shift estimation algorithm is based on minimizing a cost function, expressing mean-squared differences in brightness patterns of certain areas of the two frames. An extensive experimental evaluation program was carried out, using a computer-controlled two-axis light table with actual satellite images, a CCD camera, and a digital computer for the on-line implementation of the algorithm. The robustness and accuracy characteristics of the method were investigated with regard to relevant parameters such as: image texture content, camera focal length, sampling rate, and the number of pixels processed. The results demonstrate high robustness for a wide range of parameters. ISA

N93-27195 Israel Aircraft Industries Ltd., Yehud. Faculty of Aerospace Engineering.

ATTITUDE STABILIZATION OF BIAS MOMENTUM SATELLITES **c18**

Marcel Sidi *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 243-251 (For primary document see N93-27166 10-01)

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In earth pointing satellites the use of momentum bias is a common practice for stabilizing against external disturbances. This approach is of great utility, especially in systems in which the measurement of the yaw angle is not available. The momentum bias provides a natural gyroscopic stability, however, harmonic external disturbances or energy dissipation in the rotor of the momentum wheel might cause instability effects of the nutation or orbital dynamics. An active control is necessary to prevent this possibility. Whatever the control moments should be, magnetic, solar, or hydrazine thrusters, the design of the control law is, in general, based on approximate techniques because of the impossibility of separating the x-from the z-axis dynamics. A way is suggested to design a controller that meets exactly the stability and disturbance attentuation specifications. ISA

N93-27196 Technion - Israel Inst. of Tech., Haifa.

DYNAMICS AND CONTROL OF A FREE FLYING TWO ARMED ROBOT IN SPACE Abstract Only **c18**

Liron Ernwald, M. Guelman (Rafael Armament Development Authority, Haifa, Israel.), and P. T. L. M. vanWoerkom (National Aerospace Lab., Amsterdam, Netherlands.) *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 252-253 (For primary document see N93-27166 10-01)

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Control of a robot manipulator in space is complicated by the effects of reaction forces and torques on the robot base, the resulting motion of which contributes to the resultant motion of the manipulator. The operational space approach to control is generalized for the case of a free-flying robot in space, with two manipulator arms. A system model was developed on the basis of the recursive Newton Euler algorithm. System matrices and vectors were partitioned to define the control structure, and control algorithms were developed. It is shown that the robot base and the end effectors are free to behave independently and to achieve their required inertial position and altitude as required. It is shown that small errors in assumed payload characteristics can cause system oscillations and even render the system unstable. An algorithm was developed which is robust with respect to generalized modeling errors, and an algorithm based on the use of an observer together with feedforward and feedback loops was proposed. It is shown that in the limit, this observer behaves as if the joint angular acceleration were directly available to the system. The basic idea is generalized for the free-flying robot, by assuming that angular accelerations are measured at each joint. This additional information enables an exact online computation to be performed, of the components of the generalized matrix of inertia and the Coriolis/centripetal vector. This exact computation facilitates the assurance of robust robot control. ISA

N93-27197 Technion - Israel Inst. of Tech., Haifa. Faculty of Aerospace Engineering.

TechSAT ATTITUDE CONTROL **c18**

M. Shachar and R. Vansover *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 254-265 (For primary document see N93-27166 10-01)

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TechSAT is an academic program of the Technion-Israel Institute of Technology. Emphasizing new engineering solutions, the program will develop a low-cost, 50-kg microsat that is sun-synchronized, 3-axis stabilized, nadir pointing, and piggyback launched by Ariane. Actually, it is a gyrostat that is based on the following: a momentum wheel, a static horizon sensor, three magnetotorquers, and a 3-axis magnetometer. The devices are all especially designed for TechSAT and have a total power consumption of less than 3 W. The satellite is designed to be released with unknown attitude and with zero stored momentum. The wheel is accelerated to its biased momentum; the body is slowly controlled to become stabilized, using algorithms that utilize magnetometer data only, to an accuracy of 5 deg, which is considered a coarse cruise. Then, the fine cruise uses the static horizon sensor to achieve a final accuracy of 0.1 deg. ISA

N93-27198 Israel Aircraft Industries Ltd., Yehud. Space Technology Dept.

OFEQ-2 ORBIT, ATTITUDE, AND FLIGHT EVALUATION **c18**

Michael Grumer, Joseph Komem, Joseph Kronenfeld, Ophir Kubitski, Vitaly Lorber, and Haim Shyldkrot *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 266-278 (For primary document see N93-27166 10-01)

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The most significant events and phenomena that occurred during the Ofeq-2 flight are evaluated in this work. Particular attention is paid to the physical and technological factors which affected its orbital lifetime. Comparison of Ofeq-2 telemetry results with prelaunch estimations and with Ofeq-1 flight data are presented. The satellite's orbit and mission characteristics are defined and the principal systems of Ofeq-2 are described. Topics addressed include the interaction between the spinner's attitude with respect to the sun and consequent electric power generation. The coning angle development history, the role of the solar data evaluation, and the factors influencing drag are also analyzed. All of these affected the Ofeq-2 power outage-recovery event. The orbit determination and the coning angle evolution estimation methods are discussed in some detail. A brief report on radiation effects on computer RAM (random access memory) is also given. An integrative systems engineering approach summary of the telemetry data reconstruction and analysis concludes the paper. ISA

N93-27199 Universidade Estadual de Paulista, Guaratingueta (Brazil). Dept. de Matematica.

EFFECTS OF SOLAR RADIATION PRESSURE TORQUE ON THE ROTATIONAL MOTION OF AN ARTIFICIAL SATELLITE **c18**

M. Cecilia F. P. S. Zanardi and Rodolpho VilhenadeMoraes (ITA Astronomical Observatory, Sao Jose dos Campos, Brazil.) *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 279-286 (For primary document see N93-27166 10-01)

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The motion of an artificial satellite about its center of mass is studied considering torques due to the gravity gradient and direct solar radiation pressure. A model for direct solar radiation torque is derived for a circular cylindrical satellite. An analytical solution is obtained by the method of variation of parameters. This solution shows that the angular variables have secular variation, but the modulus of the rotational angular momentum on the z-axis of the moment of inertia and inertial axis suffer only periodic variations. A numerical application considering a hypothetical artificial satellite is shown. ISA

N93-27200 Israel Aircraft Industries Ltd., Yehud. MBT.

MINIMUM NUMBER OF SATELLITES FOR EARTH COVERAGE BY A CONSTELLATION OF LOW-ORBIT SATELLITES **c18**

Marcel Sidi and Yoram Yaniv *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 287-294 (For primary document see N93-27166 10-01)

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An analytical way for computing the minimum number of satellites in a low-orbit multi-satellite system with a 100 percent coverage requirement is described. A Walker delta pattern constellation is assumed for a certain class of earth coverage definition. To provide coverage of a particular ground station, the satellite orbital plane inclination must be equal to or greater than the latitude of the ground station. The analysis yields the number of satellites in each orbital plane and the number of such groups necessary, in terms of the height of the orbits. An efficient numerical simulation was prepared in order to check the analytical results; the agreement between the analytical results and the simulation was perfect. ISA

N93-27201 Israel Aircraft Industries Ltd., Yehud. Space Technology Dept.

DEVELOPMENT OF IR RADIATION SIMULATOR FOR SPACECRAFT THERMAL TESTING **c14**

Yoram Shimrony, Zachary Bachmutsky, Yaron Naimark, and Sylvia Zalmanovich *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 295-303 (For primary document see N93-27166 10-01)

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An infrared (IR) simulator was developed to verify the thermal design of the Ofeq satellite. A thermal model (TM) of the satellite, which was to be exposed to IR fluxes, was validated in a solar simulator at a European space center. Development of the IR simulator included the development of heat-flux mapping software. The software is to be used in determining the positioning of heat sources in the IR simulator. A special structure was designed and fabricated for zoning and for attaching lamps and sensors, and a heat-flux and temperature monitoring and controlling system was installed to ensure the safety of the satellite during the tests. A special heat sensor was developed for the wavelength-independent measurement of the energy absorbed by the satellite surfaces. Thus, tests with IR radiation would be applicable to the calculation of the effects of solar radiation. The results of the simulation tests indicated the technique to be a valid thermal design tool for satellites. ISA

N93-27202 Technion - Israel Inst. of Tech., Haifa.

VERTICAL LANDING ON AN ASTEROID **c12**

D. Harel and M. Guelman (Rafael Armament Development Authority, Haifa, Israel.) *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 304-310 (For primary document see N93-27166 10-01)
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This work is concerned with the final approach phase and vertical landing on an asteroid with a power limited, electrically propelled spacecraft. With gravitational effects taken into account, a new solution to the fuel optimal vertical landing on an asteroid was obtained. In this solution, the spacecraft commanded acceleration is explicitly expressed as a function of vehicle velocity and time to go. Based on qualitative methods of analysis, the guidance strategy and the resulting trajectories were studied. It is shown that these fuel optimal trajectories effectively assure a vertical soft landing on the asteroid. Results of numerical simulations for the vertical landing starting from an elliptical orbit are presented. ISA

N93-27203 Israel Aircraft Industries Ltd., Yehud. Systems and Space Technology.
SOLAR SAIL ATTITUDE CONTROL INCLUDING ACTIVE NUTATION DAMPING IN A FIXED-MOMENTUM WHEEL SATELLITE **c18**
Ruth Azor *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 311-317 (For primary document see N93-27166 10-01)
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In the geostationary cruise of a momentum biased satellite, it is necessary to stabilize the roll/yaw attitude due to disturbances caused by solar radiation pressure. This work presents a roll/yaw control system with a horizon sensor for roll measurement. Roll/yaw control is obtained by the use of solar arrays and fixed flaps as actuators. The design also includes an active nutation damping method. ISA

N93-27204 Technion - Israel Inst. of Tech., Haifa. Faculty of Aerospace Engineering.
INTERACTIVE METHOD FOR PLANNING CONSTRAINED FUEL OPTIMAL PROXIMITY OPERATIONS **c13**
A. Abramovitz and A. Grunwald *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 318-329 (For primary document see N93-27166 10-01)
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An interactive technique for planning a fuel optimal rendezvous in the proximity of the space station is presented. The approach employed provides a method for determining the spatially constrained impulsive maneuver between two completely arbitrary chaser and target trajectories. The maneuver is to be executed in a limited task time. The proximity operations are described by the relative motion equations. The optimization method is based on the primer vector and its extension to non-optimal trajectories. The optimal number, direction, and magnitude of the impulses could thus be found. A variety of different design examples were presented, and the tool was evaluated. In many cases a fuel savings of up to 30% could be accomplished by adding an intermediate impulse. Similar fuel savings could be achieved by initial and final arcs. Most of the optimal solutions were quite counter-intuitive and could not have been found without the use of the optimization tools implemented herein. Operating the system was proved to be very easy and did not require any previous in-depth knowledge of the relevant theoretical background. Trade off-studies of fuel consumption versus task time were obtained with this method. ISA

N93-27205 Tel-Aviv Univ. (Israel). Dept. of Electronic Systems.
MINIMUM EFFORT INTERCEPTION OF MULTIPLE TARGETS **c13**
Joseph Z. Ben-Asher *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 330-334 (For primary document see N93-27166 10-01)
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The problem of optimal multiple-target interception is investigated. The cost is a measure of the control effort, and the problem is studied in a linear form. The main contribution of this work is the generalization of an optimal feedback law, previously formulated for the two-target case, for cases with an arbitrary number of targets. Some numerical examples, obtained by both open-loop and closed-loop methods, are presented. ISA

N93-27206 Technion - Israel Inst. of Tech., Haifa. Faculty of Aerospace Engineering.
A SIMPLIFIED DYNAMIC GAME MODEL FOR ANTI-MISSILE DEFENSE SCENARIOS **c66**
G. Silberman and J. Shinar *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 335-343 (For primary document see N93-27166 10-01)
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A discretized game model of an anti-missile defense scenario is presented. Such an engagement is a pursuit of a 'blind' evader with the evader subject to a trajectory constraint. The model can be formulated as an incomplete information zero-sum pursuit-evasion game with state constraint. Such a game becomes non-trivial if the evader has higher maneuverability than the pursuer. In this case the game admits a saddle-point solution in mixed strategies. Two simple examples illustrate the major elements of the solution. ISA

N93-27207 Technion - Israel Inst. of Tech., Haifa. Faculty of Aerospace Engineering.
GUIDANCE LAW SYNTHESIS AND EVALUATION FOR A STRAPDOWN SEEKER APPLICATION **c04**
Michael Wetzler and Josef Shinar *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 344-354 (For primary document see N93-27166 10-01)
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The synthesis and performance of a low-cost precision-guided munition with a strapdown electro-optical seeker, designed to be used against stationary and slow moving targets is presented. To perform the terminal guidance, the law of Dynamic Lead Guidance was selected. The implementation of this guidance law is based on a strapdown seeker, a position gyro, and a feedback network, for which the prior knowledge of the aerodynamic lag is required. The design concept is validated by simulating a realistic guidance loop. For the ideal case, Dynamic Lead Guidance homing performance is similar to Proportional Navigation. If the limitation of the strapdown seeker and the acceleration capability of the guided vehicle are respected, Dynamic Lead Guidance is a cost effective guidance law for precision guided munitions applications. ISA

N93-27208 Tel-Aviv Univ. (Israel). Faculty of Engineering.
THE EFFECT OF A FINITE ROLL RATE ON THE MISS-DISTANCE OF A BANK-TO-TURN MISSILE **c08**
T. Miloh, M. Pachter (Wright Research Development Center, Wright-Patterson AFB, OH.), and A. Segal (Israel Aircraft Industries Ltd., Lod.) *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 355-362 (For primary document see N93-27166 10-01)
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We consider a three-dimensional pursuit-evasion situation where a highly maneuverable evader, which we model as a 'pedestrian,' is engaged by a faster pursuer. The pursuer has limited maneuverability, i.e. a minimal turning radius, and, in order to change the spatial direction of his velocity vector, he must first re-align his thrust vector in a similar manner to a bank-to-turn-missile. The state space of the ensuing differential game is three-dimensional, and its complexity is intermediate between the classical 'Homicidal Chauffer' and the 'Two Car' differential games (DG). This new DG is solved as a game of a kind, and a capture criterion of a faster but less maneuverable pursuer is analytically established in terms of the game parameters. ISA

N93-27209 Rafael Armament Development Authority, Haifa (Israel). Missile Div.
OPTIMIZATION OF CLOSED-LOOP TACTICS IN BALLISTIC DEFENSE-OFFENSE SCENARIOS **c66**
Moti Shefer *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992

p 363-367 (For primary document see N93-27166 10-01)
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A generic, planar, defense-offense scenario in which a surface target threatened by an intelligent ballistic attacker is defended by an anti-ballistic missile is defined. The process is formulated as a Zero-Sum Differential Game using as constraints linear, but full, dynamics for bothopponents. This yields optimal (MinMax) control laws in the form of full-state feedback with time-varying gains. The gains are known ahead of time from off-line computation. Some cases are analyzed statistically and by digital simulations. In those cases a considerable defender advantage is foreseen; This is expressed in terms of small miss distance and intercept angle as well as low defender maneuvering effort relative to that of the attacker. ISA

N93-27210 Israeli Air Force, Zahal.
DAMAGE TOLERANCE ASSESSMENT AND USAGE VARIATION ANALYSIS FOR C-130 AIRCRAFT IN THE ISRAELI AIR FORCE **c38**
D. Schur, E. Makevet, and A. Dumanis *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 368-372 (For primary document see N93-27166 10-01)
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The development of damage tolerance assessment (DTA) and individual aircraft tracking (IAT) programs for the IAF C-130 fleet is presented in this paper. An 'Aircraft Manager' computer program (USE) for usage variation analysis is described, and its application to support C-130 structural maintenance is discussed in depth. The USE computer program is applied in the assessment of usage variation effects on analytic safety limits, damage growth rates, and, consequently, on structural inspection requirements. The discussion of USE applications also highlights certain aspects of aircraft fatigue methodology and fleet management. As the IAF C-130 fleet ages, the IAF combines DTA results, IAT capability and USE applications to maintain the structural integrity of the aircraft. ISA

N93-27211 Rafael Armament Development Authority, Haifa (Israel).
KANE'S DYNAMICS **c61**
Shlomo Djerassi *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 373-384 (For primary document see N93-27166 10-01)
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Numerous modern engineering fields such as those associated with space, robotics, biomechanics, etc., call for extensive dynamical analyses. Several formulations of equations governing the motion of dynamical systems are available, e.g., D'Alembert 's Principle, Lagrange's equations, and Kane's equations. A statement often made when these formulations are compared with each other is that the application of Kane's equations requires the least amount of work and involves the shortest expressions. This statement is at the focus of the present paper, whose objectives are: (1) to discuss Kane's observations and, concurrently, to reaffirm the above statement; and (2) to introduce AUTOLEV, a computer program which generates explicit equations of motion using Kane's formulation and, subsequently, a FORTRAN code for their numerical integration. AUTOLEV is then used to generate equations governing the action of a complex system of interest in astronautics. ISA

N93-27212 Rafael Armament Development Authority, Haifa (Israel).
AIRFOIL STABILITY IN TURBULENT FLOW **c02**
A. Sternberg *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 385-391 (For primary document see N93-27166 10-01)
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Oscillatory instability of an aircraft's wing (flutter) depends on both the wing's structure and the flow conditions. A fighting aircraft in a common low-level flight mission will most likely encounter boundary layer turbulence, typical to the specific area of activity. The turbulence is considered as a wide-band random excitation, due to its high convective speed and in spite of its long characteristic length, relative to the wing width. The lowest eigenfrequency of a modern wing may be as low as 7 Hz (e.g., the F-16). Under these circumstances, turbulence may also affect the wing stability. Velocity perturbations are included in the parameters of the governing differential equations (DE), thus rendering them random-time-variant and also parametrically excited. The second-order DE's are converted into a set of first-order DE's, for which the state vector is assumed to be a Markov vector. Stability of the first and second statistical moments is considered. For the sake of simplicity, the model includes two degrees of freedom, in torsion and flexure, the flow is incompressible, and the wing is uniform with AR = infinity. Numerical results for two wings all indicate that turbulence delays instability as long as it is at a very low spectral density level. However, beyond a specific level for each case, higher turbulence would lower the critical speed. It is impossible to draw general conclusions though, since the phenomenon can only be explained hypothetically. ISA

N93-27213 Rafael Armament Development Authority, Haifa (Israel). Structural Analysis Group.
OPTIMIZATION METHOD IN NONLINEAR ANALYSIS OF A CIRCULAR ROTATING CLUSTER PACKAGE **c39**
A. Levin *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 392-397 (For primary document see N93-27166 10-01)
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A structural model of a rotating cluster package is presented as a thin circular ring containing stiff cylinders and an elastic foundation within its perimeter. The analysis of this structure consists of three nonlinear aspects: (1) geometric, due to large deflections of the ring; (2) nonlinear elastic foundations; and (3) forced deformations of the ring due to its increasing contact with the stiff cylinders. A variational approach using an optimization functional has been applied for the numerical solution. The elastic foundations, boundary conditions, and the increasing contact between the ring and the cylinders have been modeled by springs determined according to the evolving geometry of the ring. The physical interpretation of Lagrange multipliers combined with the optimization functional has been used to impose increments of displacements in the step-by-step solution. ISA

N93-27214 Tel-Aviv Univ. (Israel).
TOWARDS AN ANALYTICAL TREATMENT OF THE AEROLASTIC PROBLEM OF A CIRCULAR WING **c02**
A. Hauptman and T. Miloh *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 398-403 (For primary document see N93-27166 10-01)
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An idealized model of a thin wing of circular planform is used to analyze the aerolastic behavior of a low-aspect-ratio wing. A closed-form solution for the steady aerodynamic lifting problem is presented, based on expanding the acceleration potential of the incompressible flowfield about the wing into a series of appropriately selected ellipsoidal harmonics. The aerostatic problem is formulated, and the possibility of obtaining analytical solutions is discussed. ISA

N93-27215 Rafael Armament Development Authority, Haifa (Israel).
EROSION SENSITIVITY OF GRAPHITIC NOZZLES FOR SOLID-PROPELLANT ROCKET MOTORS **c20**
T. Shoham *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 404-411 (For primary document see N93-27166 10-01)
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A parametric study on the erosion sensitivity of graphitic nozzle throats in small-scale solid propellant rocket motors is presented. The parameters considered are the aluminum content of the solid propellant, combustion gas products of a wide range of composite solid propellants, two propellant configurations (tubular and end-burning), two propellant burning rates for each configuration, and nozzle geometry. Pressure decrease caused by the erosion at the nozzle throat is estimated for each of the two propellant configurations and burning rates. The estimations are performed for pressure values of 0.5-3.0 megapascal at the throat section. The convergence half angle of the nozzle is in the range 30-75 degrees, and the graphitic throat inserts considered are of densities 1.80-1.90 grams per cubic cm. The results obtained and the parameters defined in the work are significant

tools for the designer of the design procedure for the rocket motors. The erosion rate or the recession of the nozzle throat can be predicted in each design step of the rocket motor. ISA

N93-27216 Technion - Israel Inst. of Tech., Haifa. Faculty of Aerospace Engineering.

EVALUATION OF LOW POWER AUGMENTED HYDRAZINE THRUSTERS **c20**

Ilan Hadar and Alon Gany *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 412-419 (For primary document see N93-27166 10-01)

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A brief review of the current concepts of power addition to the widespread, low-power hydrazine thruster and a general analysis of the augmentation processes are presented. Among the devices surveyed are the resistojets (RJ) and the arcjets (AJ), which transfer electric energy by physical contact with the hydrazine decomposition gases, and the microwave thrusters (MW), which apply electromagnetic fields generated by microwaves. A comparison between the variety of present and future augmented hydrazine thrusters (AHT) suggests that the AJ is the most promising means for the energy addition procedure, when both reliability and performance are taken into account. ISA

N93-27217 Israel Military Industries, Ramat-Hasharon. Internal Ballistics Group.

COMPUTER-AIDED SURFACE REGRESSION ANALYSIS **c28**

David Horowitz *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 420-426 (For primary document see N93-27166 10-01)

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This paper describes a computer modeling code which determines the geometric properties of a solid propellant surface as a function of the burn distance. Burn and port area as well as 3D plots are available at every calculation step. The geometric data may then be used in a subsequent ballistic analysis code incorporating the classical gas dynamic equations. This burn analysis utilizes the extensive capabilities of a CAD (Computer Aided Design) program (EUCLID), which provides a programming language in addition to the interactive version. The motor void consists of primitives (revolved profiles and prisms) that are fused together and subsequently analyzed using the Boolean and measuring functions of EUCLID. The regressing surface is created by allowing the primitives to grow outwards normally to themselves and fuzing them together, thus forming a repetitive sequence which is incorporated in a computer code. A great deal of computer time is saved by utilizing the known symmetry of the grain, thereby, allowing reduction in the number of time-consuming topological operations. Excellent agreement was obtained with analytical calculations in such grains where comparisons were possible. ISA

N93-27218 Technion - Israel Inst. of Tech., Haifa. Faculty of Aerospace Engineering.

LEADING EDGE VORTICES IN A CHORDWISE PERIODIC FLOW **c02**

M. Amitay, J. Er-Al, and A. Seginer *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 427-438 (For primary document see N93-27166 10-01)

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The flow over a slender delta wing in a periodically changing free-stream is investigated, theoretically and experimentally. The theoretical model assumes the wings to be slender and infinitesimally thin with straight spanwise cross-sections. The amplitudes and frequencies of the periodic motion are assumed to be very small so that the flow is governed by the steady two-dimensional Laplace equation. Time dependence is introduced through the boundary condition. The theoretical model was validated by the visualization of the flow over a delta wing in a periodic translational motion in a water tunnel. The vortical flow field over the wing was visualized by the hydrogen-bubbles technique. The spatial trajectories of the leading edge vortices as a function of several parameters, were found from the flow visualization results. Good agreement between the theoretical and the experimental results was obtained, as long as the small-perturbations assumption was justified. The results also show that the effects of a periodic flow are comparable with those of a periodically translating wing, under these assumptions and Galilei transformation. ISA

N93-27219 Technion - Israel Inst. of Tech., Haifa. Faculty of Aerospace Engineering.

ON THE INTERACTIONS BETWEEN DETONATION WAVES AND SHOCK WAVES IN THE EXTERNAL PROPULSION METHOD FOR ACCELERATION OF PROJECTILES **c34**

Josef Rom and Gavriel Avital *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 439-445 Sponsored by V. P. R. - L. Kraus Research Fund and Asher Peled Memorial Fund (For primary document see N93-27166 10-01)

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A projectile injected into an external propulsion accelerator tube at a high supersonic velocity is accelerated by the interaction of the oblique shock wave and the detonation wave in the high-temperature/high-pressure, fuel-oxidizer gas mixture with which the tube is filled. The study described here comprises a simplified analysis of the flow structure established by the interaction of a planar oblique shock wave and a planar oblique detonation wave. Mass, momentum, and energy conservation; the Rankin-Hugoniot conditions across an oblique shock wave; and the Chapman-Jouguet detonation conditions are applied to estimate the flow field generated by the intersection of the the planar detonation wave with the planar shock wave. A transmitted wave is generated from the intersection point of the detonation and shock waves; it can be either an oblique shock wave or an additional detonation wave. The conditions for forming an additional detonation wave depend on the gas-mixture parameters and the free stream Mach number. Even the simplified planar shock wave and planar detonation wave conditions used in this analysis enable regions of stable detonation conditions to be mapped for supersonic and hypersonic flow regimes. The effects of the gas-mixture parameters and the flow parameters are presented graphically. ISA

N93-27220 National Research Council of Canada, Ottawa (Ontario). Inst. for Aerospace Research.

EFFECT OF VORTEX BEHAVIOR ON LOADS ACTING ON A 65 DEG DELTA WING OSCILLATING IN ROLL AT HIGH INCIDENCE **c02**

E. S. Hanff and X. Z. Huang *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 446-458 (For primary document see N93-27166 10-01)

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Wind-tunnel experiments conducted on a 65-degree delta wing subjected to large-amplitude high-rate oscillations in roll at high incidence have revealed the presence of nonlinear, time-dependent loads in both the longitudinal and lateral planes. Correlations between these loads and surface pressure measurements and high-speed flow visualization data indicate that the instantaneous loads are largely determined by the position of the leading edge vortex breakdown points. ISA

N93-27221 Technion - Israel Inst. of Tech., Haifa. Faculty of Aerospace Engineering.

ANALYSIS OF WIND-TUNNEL DATA FOR ELLIPTIC CROSS-SECTIONED FOREBODIES AT MACH NUMBERS 0.4 TO 5.0 **c02**

Asher Sigal and Gavriel Avital *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 459-466 (For primary document see N93-27166 10-01)

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A pre-existing database for elliptic cross-sectioned forebodies was analyzed by identifying the linear aerodynamic characteristics at small angles of attack, and by fitting a model for the vortex-induced normal-force coefficient. The parameters in the model strongly depend on Mach numbers. An attempt to predict the amplitude parameter of the model, by an extended version of the crossflow method, yielded results that underpredict the experimentally obtained values. ISA

N93-27222 Case Western Reserve Univ., Cleveland, OH.
APPLICATION OF MOLECULAR DYNAMICS TO COMPUTATIONS OF SPATIAL DISTRIBUTIONS OF GAS STREAMS FROM A SOLID SURFACE **c34**
Isaac Greber, Harold Y. Wachman (Massachusetts Inst. of Tech., Cambridge.), and Greg Kass (Wright Research Development Center, Wright-Patterson AFB, OH.) *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 467-472 (For primary document see N93-27166 10-01)
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Results are presented of molecular dynamics computations of scattering of a gas stream impinging on a solid, using a simple model of the solid but considering continuous force field interactions. The solid is modeled as a simple cubic array of particles. The particles interact with their nearest neighbors in accordance with the Lennard-Jones 6-12 force potential, which consists of a far-field attractive force and a near-field repulsive force. Gas molecules interact with molecules of the solid according to the same force law. The array of particles is bounded on five sides by constraining particles whose motion is limited, and chosen so as to model an isothermal solid. The impinging gas stream is modeled as a mono-energetic beam of molecules, which impinge on the solid one at a time at a predetermined angle of incidence. Scattering intensity distributions are presented for several ratios of gas-to-solid energy. The intensity distributions exhibit lobular behavior when the incoming beam is aimed at a fixed point. The lobular behavior is consistent with physical notions of scattering in the structure and thermal regimes. ISA

N93-27405# Boeing Commercial Airplane Co., Seattle, WA.
WORLD JET AIRPLANE INVENTORY AT YEAR-END 1992
Mar. 1993 119 p See also PB90-207218
(PB93-174324) Avail: CASI HC A06/MF A02

The document contains data on the world commercial jet airplane fleet (including some military derivatives) and reflects the status of this fleet as accurately as possible as of December 31, 1992. Any fleet changes that have occurred since year-end 1992 will not be reflected in these data. NTIS

02 AERODYNAMICS

Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.

For related information see also *34 Fluid Mechanics and Heat Transfer.*

N93-26899*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
DEVELOPMENT OF A LARGE-SCALE, OUTDOOR, GROUND-BASED TEST CAPABILITY FOR EVALUATING THE EFFECT OF RAIN ON AIRFOIL LIFT
Gaudy M. Bezos and Bryan A. Campbell Washington Apr. 1993 68 p
(RTOP 505-68-01-02)
(NASA-TM-4420; L-17004; NAS 1.15:4420) Avail: CASI HC A04/MF A01

A large-scale, outdoor, ground-based test capability for acquiring aerodynamic data in a simulated rain environment was developed at the Langley Aircraft Landing Dynamics Facility (ALDF) to assess the effect of heavy rain on airfoil performance. The ALDF test carriage was modified to transport a 10-ft-chord NACA 64210 wing section along a 3000-ft track at full-scale aircraft approach speeds. An overhead rain simulation system was constructed along a 525-ft section of the track with the capability of producing simulated rain fields of 2, 10, 30, and 40 in/hr. The facility modifications, the aerodynamic testing and rain simulation capability, the design and calibration of the rain simulation system, and the operational procedures developed to minimize the effect of wind on the simulated rain field and aerodynamic data are described in detail. The data acquisition and reduction processes are also presented along with sample force data illustrating the environmental effects on data accuracy and repeatability for the 'rain-off' test condition. Author (revised)

N93-27004*# Institute for Computer Applications in Science and Engineering, Hampton, VA.
SENSITIVITY CALCULATIONS FOR A 2D, INVISCID, SUPERSONIC FOREBODY PROBLEM Final Report
Jeff Borggaard (Virginia Polytechnic Inst., Blacksburg.), John A. Burns (Virginia Polytechnic Inst., Blacksburg.), Eugene Cliff (Virginia Polytechnic Inst., Blacksburg.), and Max Gunzburger (Virginia Polytechnic Inst., Blacksburg.) Washington Mar. 1993 14 p Submitted for publication
(Contracts NAS1-19480; F49620-92-J-0078; AF-AFOSR-0179-90; NSF INT-89-22490)
(NASA-CR-191444: NAS 1.26:191444; ICASE-93-13) Avail: CASI HC A03/MF A01

The use of a sensitivity equation method to computer derivatives for optimization based design algorithms are discussed. The problem of designing an optimal forebody simulator is used to motivate the algorithm and to illustrate the basic ideas. Finally, how an existing computational fluid dynamics (CFD) code can be modified to compute sensitivities and a numerical example is presented. Author (revised)

N93-27005*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ASSESSMENT OF A FLOW-THROUGH BALANCE FOR HYPERSONIC WIND TUNNEL MODELS WITH SCRAMJET EXHAUST FLOW SIMULATION
Lawrence D. Huebner, Marc W. Kniskern (North Carolina State Univ., Raleigh.), and William J. Monta Washington May 1993 50 p
(RTOP 505-59-40-03)
(NASA-TM-4441; L-17088; NAS 1.15:4441) Avail: CASI HC A03/MF A01

The purpose of this investigation were twofold: first, to determine whether accurate force and moment data could be obtained during hypersonic wind tunnel tests of a model with a scramjet exhaust flow simulation that uses a representative nonwatercooled, flow-through balance; second, to analyze temperature time histories on various parts of the balance to address thermal effects on force and moment data. The tests were conducted in the NASA Langley Research Center 20-Inch Mach 6 Wind Tunnel at free-stream Reynolds numbers ranging from 0.5 to 7.4 x 10(exp 6)/ft and nominal angles of attack of -3.5 deg, 0 deg, and 5 deg. The simulant exhaust gases were cold air, hot air, and a mixture of 50 percent Argon and 50 percent Freon by volume, which reached stagnation temperatures within the balance of 111, 214, and 283 F, respectively. All force and moment values were unaffected by the balance thermal response from exhaust gas simulation and external aerodynamic heating except for axial-force measurements, which were significantly affected by balance heating. This investigation showed that for this model at the conditions tested, a nonwatercooled, flow-through balance is not suitable for axial-force measurements during scramjet exhaust flow simulation tests at hypersonic speeds. In general, heated exhaust gas may produce unacceptable force and moment uncertainties when used with thermally sensitive balances. Author (revised)

N93-27032*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
TRANSITION AERODYNAMICS FOR 20-PERCENT-SCALE VTOL UNMANNED AERIAL VEHICLE
Kevin J. Kjerstad and John W. Paulson, Jr. Washington Apr. 1993 51 p Original contains color illustrations
(RTOP 505-59-30-02)
(NASA-TM-4419; L-17112; NAS 1.15:4419) Avail: CASI HC A04/MF A01; 2 functional color pages

An investigation was conducted in the Langley 14- by 22-Foot Subsonic Tunnel to establish a transition data base for an unmanned aerial vehicle utilizing a powered-lift ejector system and to evaluate alterations to the ejector system for improved vehicle performance. The model used in this investigation was a 20-percent-scale, blended-body, arrow-wing configuration with integrated twin rectangular ejectors. The test was conducted from hover through transition conditions with variations in angle of attack, angle of sideslip, free-stream dynamic pressure, nozzle pressure ratio, and model ground height. Force and moment data along with extensive surface pressure data were obtained. A laser velocimeter technique for measuring inlet flow velocities was demonstrated at a single flow condition, and also a low

order panel method was successfully used to numerically simulate the ejector inlet flow. Author

N93-27067*# Vigyan Research Associates, Inc., Hampton, VA.
UNSTRUCTURED VISCOUS GRID GENERATION BY ADVANCING-FRONT METHOD
Shahyar Pirzadeh Apr. 1993 26 p
(Contract NAS1-19672; RTOP 505-59-53-05)
(NASA-CR-191449; NAS 1.26:191449) Avail: CASI HC A03/MF A01

A new method of generating unstructured triangular/tetrahedral grids with high-aspect-ratio cells is proposed. The method is based on new grid-marching strategy referred to as 'advancing-layers' for construction of highly stretched cells in the boundary layer and the conventional advancing-front technique for generation of regular, equilateral cells in the inviscid-flow region. Unlike the existing semi-structured viscous grid generation techniques, the new procedure relies on a totally unstructured advancing-front grid strategy resulting in a substantially enhanced grid flexibility and efficiency. The method is conceptually simple but powerful, capable of producing high quality viscous grids for complex configurations with ease. A number of two-dimensional, triangular grids are presented to demonstrate the methodology. The basic elements of the method, however, have been primarily designed with three-dimensional problems in mind, making it extendible for tetrahedral, viscous grid generation. Author

N93-27084*# Stanford Univ., CA. Dept. of Aeronautics and Astronautics.
HYPERSONIC PANEL FLUTTER IN A RAREFIED ATMOSPHERE
Hugo B. Resende Washington May 1993 116 p
(Grant NGL-05-020-243; RTOP 505-63-50)
(NASA-CR-4514; NAS 1.26:4514; SUDAAR-614) Avail: CASI HC A06/MF A02

Panel flutter is a form of dynamic aeroelastic instability resulting from the interaction between motion of an aircraft structural panel and the aerodynamic loads exerted on that panel by air flowing past one of the faces. It differs from lifting surface flutter in the sense that it is not usually catastrophic, the panel's motion being limited by nonlinear membrane stresses produced by the transverse displacement. Above some critical airflow condition, the linear instability grows to a limit cycle . The present investigation studies panel flutter in an aerodynamic regime known as 'free molecule flow', wherein intermolecular collisions can be neglected and loads are caused by interactions between individual molecules and the bounding surface. After collision with the panel, molecules may be reflected specularly or reemitted in diffuse fashion. Two parameters characterize this process: the 'momentum accommodation coefficient', which is the fraction of the specularly reflected molecules; and the ratio between the panel temperature and that of the free airstream. This model is relevant to the case of hypersonic flight vehicles traveling at very high altitudes and especially for panels oriented parallel to the airstream or in the vehicle's lee. Under these conditions the aerodynamic shear stress turns out to be considerably larger than the surface pressures, and shear effects must be included in the model. This is accomplished by means of distributed longitudinal and bending loads. The former can cause the panel to buckle. In the example of a simply-supported panel, it turns out that the second mode of free vibration tends to dominate the flutter solution, which is carried out by a Galerkin analysis. Several parametric studies are presented. They include the effects of (1) temperature ratio; (2) momentum accommodation coefficient; (3) spring parameters, which are associated with how the panel is connected to adjacent structures; (4) a parameter which relates compressive end load to its value which would cause classical column buckling; (5) a parameter proportional to the pressure differential between the front and back faces; and (6) initial curvature. The research is completed by an investigation into the possibility of accounting for molecular collisions, which proves to be infeasible given the speeds of current mainframe supercomputers. Author (revised)

N93-27090*# Institute for Computer Applications in Science and Engineering, Hampton, VA.
GODUNOV-TYPE SCHEMES APPLIED TO DETONATION FLOWS Final Report
James J. Quirk Washington NASA Apr. 1993 21 p Presented at the 2nd ICASE/NASA LaRC Combustion Workshop, 12-14 Oct. 1992
(Contract NAS1-19480; RTOP 505-90-52-01)
(NASA-CR-191447; NAS 1.26:191447; ICASE-93-15) Avail: CASI HC A03/MF A01

Over recent years, a variety of shock-capturing schemes have been developed for the Euler equations of gas dynamics. During this period, it has emerged that one of the more successful strategies is to follow Godunov's lead and utilize a nonlinear building block known as a Riemann problem. Now, although Riemann solver technology is often thought of as being mature, there are in fact several circumstances for which Godunov-type schemes are found wanting. Indeed, one inherent deficiency is so severe that if left unaddressed, could preclude such schemes from being used to capture detonation fronts in simulations of complex flow phenomena. In this paper, we highlight this particular deficiency along with some other little known weaknesses of Godunov-type schemes, and we outline one strategy that we have used to good effect in order to produce reliable high resolution simulations of both reactive and nonreactive shock wave phenomena. In particular, we present results for simulations of so-called galloping instabilities and detonation cell phenomena. Author

N93-27093*# California Polytechnic State Univ., San Luis Obispo.
AERODYNAMIC ANALYSIS OF HYPERSONIC WAVERIDER AIRCRAFT Final Report, 1 Oct. 1991 - 30 Sep. 1993
Doral R. Sandlin and David N. Pessin Apr. 1993 103 p
(Grant NAG2-766)
(NASA-CR-192981; NAS 1.26:192981) Avail: CASI HC A06/MF A02

The purpose of this study is to validate two existing codes used by the Systems Analysis Branch at NASA ARC, and to modify the codes so they can be used to generate and analyze waverider aircraft at on-design and off-design conditions. To generate waverider configurations and perform the on-design analysis, the appropriately named Waverider code is used. The Waverider code is based on the Taylor-Maccoll equations. Validation is accomplished via a comparison with previously published results. The Waverider code is modified to incorporate a fairing to close off the base area of the waverider configuration. This creates a more realistic waverider. The Hypersonic Aircraft Vehicle Optimization Code (HAVOC) is used to perform the off-design analysis of waverider configurations generated by the Waverider code. Various approximate analysis methods are used by HAVOC to predict the aerodynamic characteristics, which are validated via a comparison with experimental results from a hypersonic test model.
Author (revised)

N93-27096*# High Technology Corp., Hampton, VA.
ROUGHNESS-INDUCED GENERATION OF CROSSFLOW VORTICES IN THREE-DIMENSIONAL BOUNDARY LAYERS
Meelan Choudhari Washington May 1993 62 p
(Contract NAS1-19299; RTOP 537-03-23-03)
(NASA-CR-4505; NAS 1.26:4505) Avail: CASI HC A04/MF A01

The receptivity theory of Goldstein and Ruban is extended within the nonasymptotic (quasi-parallel) framework of Zavol'skii et al to predict the roughness-induced generation of stationary and nonstationary instability waves in three-dimensional, incompressible boundary layers. The influence of acoustic-wave orientation, as well as that of different types of roughness geometries, including isolated roughness elements, periodic arrays, and two-dimensional lattices of compact roughness shapes, as well as random, but spatially homogeneous roughness distributions, is examined. The parametric study for the Falkner-Skan-Cooke family of boundary layers supports our earlier conjecture that the initial amplitudes of roughness-induced stationary vortices are likely to be significantly larger than the amplitudes of similarly induced nonstationary vortices in the presence of acoustic disturbances in the free stream. Maximum unsteady receptivity occurs when the acoustic velocity fluctuation is aligned with the wavenumber vector of the unsteady vortex mode. On the other hand, roughness arrays that are oriented somewhere close to the group velocity direction are likely to produce higher instability amplitudes. Limitations of the nonasymptotic theory are discussed, and future work is suggested.
Author

N93-27097*# Sverdrup Technology, Inc., Cleveland, OH.
NUMERICAL SIMULATION OF FREE SHEAR FLOWS: TOWARDS A PREDICTIVE COMPUTATIONAL AEROACOUSTICS CAPABILITY
W. Y. Soh Apr. 1993 26 p

(Contract NAS3-25266; RTOP 505-62-52)
(NASA-CR-191015; E-7821; NAS 1.26:191015) Avail: CASI HC A03/MF A01

Implicit and explicit spatial differencing techniques with fourth order accuracy have been developed. The implicit technique is based on the Pade compact scheme. A Dispersion Relation Preserving concept has been incorporated into both of the numerical schemes. Two dimensional Euler computation of a spatially-developing free shear flow, with and without external excitation, has been performed to demonstrate the capability of numerical schemes developed. Results are in good agreement with theory and experimental observation regarding the growth rate of fluctuating velocity, the convective velocity, and the vortex-pairing process. Author

N93-27123*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

A SHADOWGRAPH STUDY OF TWO PROPOSED SHUTTLE-C LAUNCH VEHICLE CONFIGURATIONS

A. M. Springer and D. C. Pokora Washington May 1993 45 p
(NASA-RP-1303; M-718; NAS 1.61:1303) Avail: CASI HC A03/MF A01

A shadowgraph study concerning two of the proposed Shuttle-C launch vehicle configurations are presented. These shadowgraphs were obtained from a wind tunnel test performed in Marshall Space Flight Center's 14-in trisonic wind tunnel at various angles-of-attack and roll angles over the Mach range of 0.6 to 4.96. Variations in payload bay length were also evaluated. Major flow field phenomena can easily be seen in the shadowgraphs. Shadowgraphs are a valuable resource. They are used in the analysis of the external flow conditions the launch vehicle encounters through the ascent stage of flight. Subsequent reports will contain shadowgraph studies for other launch vehicle configurations also tested in the Marshall Space Flight Center's 14-in trisonic wind tunnel.

Author (revised)

N93-27126*# Texas Univ., Austin.

THE CENTER OF EXCELLENCE FOR HYPERSONICS TRAINING AND RESEARCH AT THE UNIVERSITY OF TEXAS AT AUSTIN Final Report

David S. Dolling Apr. 1993 15 p
(Grant NAGw-964)
(NASA-CR-193070; NAS 1.26:193070) Avail: CASI HC A03/MF A01

Over the period of this grant (1986-92), 23 graduate students were supported by the Center and received education and training in hypersonics through MS and Ph.D. programs. An additional 8 Ph.D. candidates and 2 MS candidates, with their own fellowship support, were attracted to The University of Texas and were recruited into the hypersonics program because of the Center. Their research, supervised by the 10 faculty involved in the Center, resulted in approximately 50 publications and presentations in journals and at national and international technical conferences. To provide broad-based training, a new hypersonics curriculum was created, enabling students to take 8 core classes in theoretical, computational, and experimental hypersonics, and other option classes over a two to four semester period. The Center also developed an active continuing education program. The Hypersonics Short Course was taught 3 times, twice in the USA and once in Europe. Approximately 300 persons were attracted to hear lectures by more than 25 of the leading experts in the field. In addition, a hypersonic aerodynamics short course was offered through AIAA, as well as short courses on computational fluid dynamics (CFD) and advanced CFD. The existence of the Center also enabled faculty to leverage a substantial volume of additional funds from other agencies, for research and graduate student training. Overall, this was a highly successful and highly visible program. Author

N93-27150*# Stanford Univ., CA. Dept. of Aeronautics and Astronautics.

AN AERODYNAMIC MODEL FOR ONE AND TWO DEGREE OF FREEDOM WING ROCK OF SLENDER DELTA WINGS

John Hong May 1993 52 p Sponsored by NASA. Ames Research Center
(NASA-CR-193130; NAS 1.26:193130; JIAA-TR-109) Avail: CASI HC A04/MF A01

The unsteady aerodynamic effects due to the separated flow around slender delta wings in motion were analyzed. By combining the unsteady flow field solution with the rigid body Euler equations of motion, self-induced wing rock motion is simulated. The aerodynamic model successfully captures the qualitative characteristics of wing rock observed in experiments. For the one degree of freedom in roll case, the model is used to look into the mechanisms of wing rock and to investigate the effects of various parameters, like angle of attack, yaw angle, displacement of the separation point, and wing inertia. To investigate the roll and yaw coupling for the delta wing, an additional degree of freedom is added. However, no limit cycle was observed in the two degree of freedom case. Nonetheless, the model can be used to apply various control laws to actively control wing rock using, for example, the displacement of the leading edge vortex separation point by inboard span wise blowing. Author (revised)

N93-27274# Defence Research Agency, Farnborough (England). Aerospace Division.

THE EXPERIMENTAL STUDY OF TRANSITION AND LEADING EDGE CONTAMINATION OF SWEPT WINGS [ETUDE DE LA TRANSITION ET DE LA CONTAMINATION DE BORD D'ATTAQUE SUR ALLES EN FLECHE]

D. Arnal, J. C. Juillen, and C. Betts, ed. Mar. 1992 24 p Presented at a conference, 1988 Original language document was announced as N90-10362
(Lib-Trans-2197) Copyright Avail: CASI HC A03/MF A01

The transition mechanisms in an incompressible laminar boundary layer developing on swept wings is investigated experimentally. The transition is detected by using hot films glued on the model. Two series of experiments are presented. In the first one, the sensors are placed along the chord, and the instantaneous signals allow us to analyze the problems of streamwise instability, crossflow instability, and leading edge contamination. In the second series of experiments, hot films are glued along the space direction, close to the leading edge. The leading edge contamination is studied in detail, and the possibilities of relaminarization are examined. CASI

N93-27282*# Brown Univ., Providence, RI. Div. of Engineering.

PARAMETER IDENTIFICATION FOR NONLINEAR AERODYNAMIC SYSTEMS Final Technical Report, 23 Oct. 1989 - 28 Feb. 1993

Allan E. Pearson May 1993 16 p
(Grant NAG1-1065)
(NASA-CR-193072; NAS 1.26:193072) Avail: CASI HC A03/MF A01

This final technical report covers a three and one-half year period preceding February 28, 1993 during which support was provided under NASA Grant NAG-1-1065. Following a general description of the system identification problem and a brief survey of methods to attack it, the basic ideas behind the approach taken in this research effort are presented. The results obtained are described with reference to the published work, including the five semiannual progress reports previously submitted and two interim technical reports. Derived from text

N93-27413# Draper (Charles Stark) Lab., Inc., Cambridge, MA.

AERODYNAMIC FORCES ON MAGLEV VEHICLES Final Report, Jul. 1991 - Nov. 1992

T. Barrows, D. McCullum, S. Mark, and R. C. Castellino Dec. 1992 188 p Sponsored by National Maglev Initiative (FRA), Washington, DC LIMITED REPRODUCIBILITY: More than 20% of this document may be affected by microfiche quality
(Contract DTFR53-91-C-00072)
(PB93-154813; CSDL-R-2463; DOT/FRA/NMI-92/21) Avail: Issuing Activity (National Technical Information Service (NTIS))

The results of four separate tasks are documented: (1) minimization of front-end drag, (2) effect of fineness ratio (ratio of length to diameter) on drag, (3) design of aerosurfaces for control purposes, and (4) control and dynamics of maglev vehicles with aerodynamic control surfaces. Task 1 examines the flow disturbances near the nose of a high speed channel vehicle which cause vortices to form near the tops of the guidewalls. These vortices are a major source of drag. The nose of the train can be idealized as a source flow, and the walls of the channel guideway are represented as two vertical flat plates. A numerical solution of the two-dimensional unsteady problem is presented. Using a representative design example, the nose shape which provides the minimum drag is derived from this solution. Under task 2, drag data is presented from the automotive industry, the Japanese National Railway, Krauss-Maffei, and Tracked Hovercraft Limited. An empirical formula is used to estimate the drag of vehicles designed for channel and box beam guideways. The optimum width for these cases is derived. Under task 3, a simple numerical

scheme is described for computing the lift and drag on an aerosurface with a control flap operating in close proximity to a guideway surface. It is shown that large variations in lift can be produced using very small flap angles. Task 4 examines the improvement in ride quality (or conversely the increase in allowable guideway roughness for a given ride quality) which is possible through the use of aerodynamic control surfaces. Comparisons are made between vehicles with active and passive secondary suspensions with aerodynamic control surfaces mounted on the vehicle body or control flaps on the vehicle bodies. NTIS

N93-27427*# California State Univ., Long Beach.
THE FIFTH SYMPOSIUM ON NUMERICAL AND PHYSICAL ASPECTS OF AERODYNAMIC FLOWS Final Report
1992 437 p Symposium held in Long Beach, CA, 13-15 Jan. 1992 Sponsored in part by ONR and Army Research Center
(Grant NAG2-726)
(NASA-CR-193000; NAS 1.26:193000) Avail: CASI HC A19/MF A04

This volume contains the papers presented at the Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows, held at the California State University, Long Beach, from 13 to 15 January 1992. The symposium, like its immediate predecessors, considers the calculation of flows of relevance to aircraft, ships, and missiles with emphasis on the solution of two-dimensional unsteady and three-dimensional equations. For individual titles, see N93-27428 through N93-27468.

N93-27428*# Stanford Univ., CA. Dept. of Mechanical Engineering.
TURBULENCE: THE CHIEF OUTSTANDING DIFFICULTY OF OUR SUBJECT
Peter Bradshaw *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 11 p (For primary document see N93-27427 10-02)
Avail: CASI HC A03/MF A04

A review of interesting current topics in turbulence research is decorated with examples of popular fallacies about the behavior of turbulence. Topics include the status of the Law of the Wall, especially in compressible flow; analogies between the effects of Reynolds numbers, pressure gradient, unsteadiness and roughness change; the status of Kolmogorov's universal equilibrium theory and local isotropy of the small eddies; turbulence modelling, with reference to universality, pressure-strain modelling and the dissipation equation; and chaos. Fallacies include the mixing-length concept; the effect of pressure gradient on Reynolds shear stress; the separability of time and space derivatives; models of the dissipation equation; and chaos. Author

N93-27429*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
THE TRANSITION PREDICTION TOOLKIT: LST, SIT, PSE, DNS, AND LES
Thomas A. Zang, Chau-Lyan Chang (High Technology Corp., Hampton, VA.), and Lian L. Ng (Analytical Services and Materials, Inc., Hampton, VA.) *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 13 p (For primary document see N93-27427 10-02)
(Contracts NAS1-18240; NAS1-18599)
Avail: CASI HC A03/MF A04

The e(sup N) method for predicting transition onset is an amplitude ratio criterion that is on the verge of full maturation for three-dimensional, compressible, real gas flows. Many of the components for a more sophisticated, absolute amplitude criterion are now emerging: receptivity theory, secondary instability theory, parabolized stability equations approaches, direct numerical simulation and large-eddy simulation. This paper will provide a description of each of these new theoretical tools and provide indications of their current status. Author

N93-27430*# Institut fuer Theoretische Stroemungsmechanik, Goettingen (Germany).
ON THE ROLE OF SECONDARY INSTABILITIES IN LAMINAR-TURBULENT TRANSITION OF 2D AND 3D BOUNDARY LAYERS Abstract Only **c34**
Uwe Dallman, Thomas M. Fischer, Werner Koch, and Hans Bippes (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen, Germany.) *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 1 p (For primary document see N93-27427 10-02)
Avail: CASI HC A01/MF A04

The accurate prediction of laminar/turbulent transition is one of the fundamental problems in engineering fluid mechanics. There is almost unanimous consent that such a transition criterion should come from stability theory. Linear primary stability theory describes the initial stage of transition, but falls short of predicting transition. Only in conjunction with empirical correlations, the widely used e(sup n) method is obtained, which, however, lacks a solid physical base. Three-dimensional secondary instabilities are known to play an important role in the transition process. However, no use has been made so far of secondary instabilities, instability interactions or wave resonances to define a 'transition location'. The paper summarizes new attempts to identify certain interaction and resonance phenomena within the laminar-turbulent transition regime in two and three-dimensional boundary layers which are associated with rapid structural and temporal changes of fluctuations beyond their exponential growths. Author

N93-27431*# Centre d'Etudes et de Recherches, Toulouse (France).
THREE-DIMENSIONAL COMPRESSIBLE STABILITY-TRANSITION CALCULATIONS USING THE SPATIAL THEORY
R. Niethammer (Ludwig-Maximilians-Univ., Munich, Germany.), D. Arnal, V. deLaharpe (California State Univ., Long Beach.), H. H. Chen (California State Univ., Long Beach.), and T. Cebeci (California State Univ., Long Beach.) *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 12 p (For primary document see N93-27427 10-02)
Avail: CASI HC A03/MF A04

The e(exp n)-method is employed with the spatial amplification theory to compute the onset of transition on a swept wing tested in transonic cryogenic flow conditions. Two separate eigenvalue formulations are used. One uses the saddle-point method and the other assumes that the amplification vector is normal to the leading edge. Comparisons of calculated results with experimental data show that both formulations give similar results and indicate that the wall temperature has a rather strong effect on the value of the n factor. Author

N93-27432*# DCW Industries, La Canada, CA.
THE REMARKABLE ABILITY OF TURBULENCE MODEL EQUATIONS TO DESCRIBE TRANSITION
David C. Wilcox *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 7 p (For primary document see N93-27427 10-02)
(Contract DAAL03-89-C-0032)
Avail: CASI HC A02/MF A04

This paper demonstrates how well the k-omega turbulence model describes the nonlinear growth of flow instabilities from laminar flow into the turbulent flow regime. Viscous modifications are proposed for the k-omega model that yield close agreement with measurements and with Direct Numerical Simulation results for channel and pipe flow. These modifications permit prediction of subtle sublayer details such as maximum dissipation at the surface, k approximately y(exp 2) as y approaches 0, and the sharp peak value of k near the surface. With two transition specific closure coefficients, the model equations accurately predict transition for an incompressible flat-plate boundary layer. The analysis also shows why the k-epsilon model is so difficult to use for predicting transition. Author

N93-27433*# Arizona State Univ., Tempe. Dept. of Mechanical and Aerospace Engineering.
A COMPRESSIBLE NEAR-WALL TURBULENCE MODEL FOR BOUNDARY LAYER CALCULATIONS **c34**
R. M. C. So, H. S. Zhang, and Y. G. Lai *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 14 p (For primary document see N93-27427 10-02)
(Grant NAG1-1080)
Avail: CASI HC A03/MF A04

A compressible near-wall two-equation model is derived by relaxing the assumption of dynamical field similarity between compressible and incompressible flows. This requires justifications for extending the incompressible models to compressible flows and the formulation of the turbulent kinetic energy equation in a form similar to its incompressible

counterpart. As a result, the compressible dissipation function has to be split into a solenoidal part, which is not sensitive to changes of compressibility indicators, and a dilational part, which is directly affected by these changes. This approach isolates terms with explicit dependence on compressibility so that they can be modeled accordingly. An equation that governs the transport of the solenoidal dissipation rate with additional terms that are explicitly dependent on the compressibility effects is derived similarly. A model with an explicit dependence on the turbulent Mach number is proposed for the dilational dissipation rate. Thus formulated, all near-wall incompressible flow models could be expressed in terms of the solenoidal dissipation rate and straight-forwardly extended to compressible flows. Therefore, the incompressible equations are recovered correctly in the limit of constant density. The two-equation model and the assumption of constant turbulent Prandtl number are used to calculate compressible boundary layers on a flat plate with different wall thermal boundary conditions and free-stream Mach numbers. The calculated results, including the near-wall distributions of turbulence statistics and their limiting behavior, are in good agreement with measurements. In particular, the near-wall asymptotic properties are found to be consistent with incompressible behavior; thus suggesting that turbulent flows in the viscous sublayer are not much affected by compressibility effects. Author

N93-27434*# Korea Advanced Inst. of Science and Technology, Seoul (Republic of Korea). Dept. of Mechanical Engineering.

ANALYSIS OF THE EFFECT OF INITIAL CONDITIONS ON THE INITIAL DEVELOPMENT OF A TURBULENT JET **c34**

Soong Ki Kim, Myung Kyoon Chung, and Ji Ryong Cho *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 6 p (For primary document see N93-27427 10-02)

Avail: CASI HC A02/MF A04

The effect of the initial condition at the jet exit on the downstream evolution, particularly within the potential core length, were numerically investigated as well as with available experimental data. In order to select the most dependable computational model for the present numerical experiment, a comparative study has been performed with different turbulence models at k-epsilon level, and it was found that the k-epsilon-gammma model yields superior prediction accuracy over other conventional models. The calculated results show that the potential core length and the spreading rate the initial mixing layer are dependent on the initial length scale as well as the turbulent kinetic energy at the jet exit. Such effect of the initial length scale increases with higher initial turbulence level. An empirical parameter has been devised to collapse the calculated data of the potential core length and the spreading rate with various initial conditions onto a single curve. Author

N93-27435*# California Univ., Davis. Dept. of Mechanical, Aeronautical and Materials Engineering.

THE INFLUENCE OF BULGES ON BOUNDARY-LAYER INSTABILITY **Abstract Only** **c34**

S. Elli and C. P. vanDam *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 1 p (For primary document see N93-27427 10-02)

Avail: CASI HC A01/MF A04

Local disturbances caused by a spanwise surface corrugation affect the position of the boundary-layer transition, and so the drag, of an object. This premature transition from laminar to turbulent flow is often associated with a separation of the laminar boundary-layer from its surface. Also the roughness-induced separation bubble provides an important link between the pressure and velocity fluctuations in the environment and the development of the disturbance in the laminar boundary-layer, i.e., the receptivity problem. To investigate the influence of a laminar separation bubble on boundary-layer instability, a separated flow generated by a velocity gradient over a flat plate was analyzed by direct numerical simulation using finite-difference solutions of the Navier-Stokes equations. The bubble acts as a strong amplifier of the instability waves and a highly nonlinear flow field is shown to develop downstream of the bubble. Consequently, the results of the direct numerical simulation differ noticeably from those of the classical linear stability theory proving the fact that the nonparallel effects together with the nonlinear interactions are crucial to this flow development. In the present paper, the effect of physical perturbations such as humps and hollows on boundary-layer instability is analyzed. This problem has been considered theoretically by several researchers (e.g., Nayfeh et al., 1987 and 1990; Cebeci et al., 1988). They used linear stability theory in their approach which does not include the nonparallel nor the nonlinear effects. Therefore, to account for these important effects in studying flow over humps and hollows the direct simulation technique is being implemented in generalized coordinates. Author

N93-27436*# Technische Univ., Berlin (Germany). Inst. fuer Stromungstechnik.

STABILITY INVESTIGATIONS OF AIRFOIL FLOW BY GLOBAL ANALYSIS

Marek Morzynski and Frank Thiele (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Berlin, Germany.) *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 10 p (For primary document see N93-27427 10-02)

Avail: CASI HC A02/MF A04

As the result of global, non-parallel flow stability analysis the single value of the disturbance growth-rate and respective frequency is obtained. This complex value characterizes the stability of the whole flow configuration and is not referred to any particular flow pattern. The global analysis assures that all the flow elements (wake, boundary and shear layer) are taken into account. The physical phenomena connected with the wake instability are properly reproduced by the global analysis. This enhances the investigations of instability of any 2-D flows, including ones in which the boundary layer instability effects are known to be of dominating importance. Assuming fully 2-D disturbance form, the global linear stability problem is formulated. The system of partial differential equations is solved for the eigenvalues and eigenvectors. The equations, written in the pure stream function formulation, are discretized via FDM using a curvilinear coordinate system. The complex eigenvalues and corresponding eigenvectors are evaluated by an iterative method. The investigations performed for various Reynolds numbers emphasize that the wake instability develops into the Karman vortex street. This phenomenon is shown to be connected with the first mode obtained from the non-parallel flow stability analysis. The higher modes are reflecting different physical phenomena as for example Tollmien-Schlichting waves, originating in the boundary layer and having the tendency to emerge as instabilities for the growing Reynolds number. The investigations are carried out for a circular cylinder, oblong ellipsis and airfoil. It is shown that the onset of the wake instability, the waves in the boundary layer, the shear layer instability are different solutions of the same eigenvalue problem, formulated using the non-parallel theory. The analysis offers large potential possibilities as the generalization of methods used till now for the stability analysis. Author

N93-27437*# Illinois Univ., Urbana-Champaign. Dept. of Aeronautical and Astronautical Engineering.

AERODYNAMICS OF A FINITE WING WITH SIMULATED ICE

M. B. Bragg, A. Khodadoust, and M. Kerho *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 10 p Sponsored by NASA. Lewis Research Center (For primary document see N93-27427 10-02)

Avail: CASI HC A02/MF A04

The effect of a simulated glaze ice accretion on the aerodynamic performance of a three-dimensional wing is studied experimentally. Results are reviewed from earlier two-dimensional tests which show the character of the large leading-edge separation bubbles caused by the simulated ice accretion. The 2-D bubbles are found to closely resemble well known airfoil laminar separation bubbles. For the 3-D experiments a semispan wing of effective aspect ratio five was mounted from the sidewall of the UIUC subsonic wind tunnel. The model uses a NACA 0012 airfoil section on a rectangular planform with interchangeable tip and root sections to allow for 0- and 30-degree sweep. A three-component sidewall balance was used to measure lift, drag and pitching moment on the clean and iced model. Fluorescent oil flow visualization has been performed on the iced model and reveals extensive spanwise and vortical flow in the separation bubble aft of the upper surface horn. Sidewall interaction and spanwise nonuniformity are also seen on the unswept model. Comparisons to the computed flow fields are shown. Results are also shown for roughness effects on the straight wing. Sand grain roughness on the ice shape is seen to have a different effect than isolated 3-D roughness elements.

Author

N93-27438*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

NUMERICAL MODELING OF RUNBACK WATER ON ICE PROTECTED AIRCRAFT SURFACES **c34**

Kamel M. Al-Khalil (National Academy of Sciences - National Research Council, Washington, DC.), Theo G. Keith, Jr. (Toledo Univ., OH.), and Kenneth J. DeWitt (Toledo Univ., OH.) *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 12 p (For primary document see N93-27427 10-02)

Avail: CASI HC A03/MF A04

A numerical simulation for 'running wet' aircraft anti-icing systems is developed. The model includes breakup of the water film, which exists in regions of direct impingement, into individual rivulets. The wetness factor distribution resulting from the film breakup and the rivulet configuration on the surface are predicted in the numerical solution procedure. The solid wall is modeled as a multilayer structure and the anti-icing system used is of the thermal type utilizing hot air and/or electrical heating elements embedded with the layers. Details of the calculation procedure and the methods used are presented. Author

N93-27439*# California State Univ., Long Beach. Dept. of Aerospace Engineering.

A COMPOSITE STRUCTURED/UNSTRUCTURED-MESH EULER METHOD FOR COMPLEX AIRFOIL SHAPES

H. Hefazi and L. T. Chen (Douglas Aircraft Co., Inc., Long Beach, CA.) *In its* The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 6 p (For primary document see N93-27427 10-02)

Avail: CASI HC A02/MF A04

A general two-dimensional Euler zonal method has been developed for computing flows about complex airfoil geometries such as multielement and iced airfoils. The method utilizes a composite structured and unstructured grid generated using conformal mapping and Delaunay triangulation, respectively. The finite-volume Euler method is then modified to couple solutions in the zones with structured and unstructured grids. Solutions about an iced airfoil and a multielement airfoil are given as examples of applications of the scheme. Author

N93-27440*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

EXPERIMENTAL AND COMPUTATIONAL ICE SHAPES AND RESULTING DRAG INCREASE FOR A NACA 0012 AIRFOIL

Jaiwon Shin and Thomas H. Bond *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 10 p Previously announced as N92-28674 (For primary document see N93-27427 10-02)

Avail: CASI HC A02/MF A04

Tests were conducted in the Icing Research Tunnel (IRT) at the NASA Lewis Research Center to document the repeatability of the ice shape over the range of temperatures varying from -15 F to 28 F. Measurements of drag increase due to the ice accretion were also made. The ice shape and drag coefficient data, with varying total temperatures at two different airspeeds, were compared with the computational predictions. The calculations were made with the 2D LEWICE/IBL code which is a combined code of LEWICE and the interactive boundary layer method developed for iced airfoils. Comparisons show good agreement with the experimental data in ice shapes. The calculations show the ability of the code to predict drag increases as the ice shape changes from a rime shape to a glaze shape. Author

N93-27441*# California State Univ., Long Beach. Dept. of Aerospace Engineering.

RECENT PROGRESS IN THE ANALYSIS OF ICED AIRFOILS AND WINGS

Tuncer Cebeci, Hsun H. Chen, Kalle Kaups, and Sue Schimke *In its* The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 10 p (For primary document see N93-27427 10-02)

Avail: CASI HC A02/MF A04

Recent work on the analysis of iced airfoils and wings is described. Ice shapes for multielement airfoils and wings are computed using an extension of the LEWICE code that was developed for single airfoils. The aerodynamic properties of the iced wing are determined with an interactive scheme in which the solutions of the inviscid flow equations are obtained from a panel method and the solutions of the viscous flow equations are obtained from an inverse three-dimensional finite-difference boundary-layer method. A new interaction law is used to couple the inviscid and viscous flow solutions. The newly developed LEWICE multielement code is amplified to a high-lift configuration to calculate the ice shapes on the slat and on the main airfoil and on a four-element airfoil. The application of the LEWICE wing code to the calculation of ice shapes on a MS-317 swept wing shows good agreement with measurements. The interactive boundary-layer method is applied to a tapered iced wing in order to study the effect of icing on the aerodynamic properties of the wing at several angles of attack. Author

N93-27442*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

HIGH-LIFT AERODYNAMICS: PROSPECTS AND PLANS Abstract Only

Lawrence E. Olson *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 1 p (For primary document see N93-27427 10-02)

Avail: CASI HC A01/MF A04

The emergence of high-lift aerodynamics is reviewed as one of the key technologies to the development of future subsonic transport aircraft. Airport congestion, community noise, economic competitiveness, and safety - the drivers that make high-lift an important technology - are discussed. Attention is given to the potentially synergistic integration of high-lift aerodynamics with two other advanced technologies: ultra-high bypass ratio turbofan engines and hybrid laminar flow control. A brief review of the ongoing high-lift research program at Ames Research Center is presented. Suggestions for future research directions are made with particular emphasis on the development and validation of computational codes and design methods. It is concluded that the technology of high-lift aerodynamics analysis and design should move boldly into the realm of high Reynolds number, three-dimensional flows. Author

N93-27443*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

EFFICIENT SIMULATION OF INCOMPRESSIBLE VISCOUS FLOW OVER MULTI-ELEMENT AIRFOILS

Stuart E. Rogers, N. Lyn Wiltberger, and Dochan Kwak *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 10 p Previously announced in IAA as A92-26258 (For primary document see N93-27427 10-02)

Avail: CASI HC A02/MF A04

The incompressible, viscous, turbulent flow over single and multi-element airfoils is numerically simulated in an efficient manner by solving the incompressible Navier-Stokes equations. The computer code uses the method of pseudo-compressibility with an upwind-differencing scheme for the convective fluxes and an implicit line-relaxation solution algorithm. The motivation for this work includes interest in studying the high-lift take-off and landing configurations of various aircraft. In particular, accurate computation of lift and drag at various angles of attack, up to stall, is desired. Two different turbulence models are tested in computing the flow over an NACA 4412 airfoil; an accurate prediction of stall is obtained. The approach used for multi-element airfoils involves the use of multiple zones of structured grids fitted to each element. Two different approaches are compared: a patched system of grids, and an overlaid Chimera system of grids. Computational results are presented for two-element, three-element, and four-element airfoil configurations. Excellent agreement with experimental surface pressure coefficients is seen. The code converges in less than 200 iterations, requiring on the order of one minute of CPU time (on a CRAY YMP) per element in the airfoil configuration. Author (revised)

N93-27444*# Institute for Computer Application Research and Utilization in Science, Inc., Boston, MA.

UNSTRUCTURED MESH ALGORITHMS FOR AERODYNAMIC CALCULATIONS

D. J. Mavriplis *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 12 p (For primary document see N93-27427 10-02)

Avail: CASI HC A03/MF A04

The use of unstructured mesh techniques for solving complex aerodynamic flows is discussed. The principle advantages of unstructured

mesh strategies, as they relate to complex geometries, adaptive meshing capabilities, and parallel processing are emphasized. The various aspects required for the efficient and accurate solution of aerodynamic flows are addressed. These include mesh generation, mesh adaptivity, solution algorithms, convergence acceleration, and turbulence modeling. Computations of viscous turbulent two-dimensional flows and inviscid three-dimensional flows about complex configurations are demonstrated. Remaining obstacles and directions for future research are also outlined.
Author (revised)

N93-27445*# California State Univ., Long Beach. Dept. of Aerospace Engineering.
AN INTERACTIVE BOUNDARY-LAYER APPROACH TO MULTIELEMENT AIRFOILS AT HIGH LIFT
Tuncer Cebeci *In its* The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 12 p (For primary document see N93-27427 10-02)
Avail: CASI HC A03/MF A04

A calculation method based on an interactive boundary-layer approach to multielement airfoils is described and is applied to three types of airfoil configurations with and without flap-wells in order to demonstrate the applicability of the method to general high-lift configurations. This method, well tested for single airfoils as a function of shape, angle of attack, and Reynolds number, is here shown to apply equally well to two-element airfoils and their wakes, to a flap-well region, and to a three-element arrangement which includes the effects of co-flowing regions, a flap well, and the wake of the elements. In addition to providing accurate representation of these flows, the method is general so that its extension to three-dimensional arrangements is likely to provide a practical, accurate and efficient tool to assist the design process. Author (revised)

N93-27446*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
REYNOLDS AND MACH NUMBER EFFECTS ON MULTIELEMENT AIRFOILS
Walter O. Valarezo (Douglas Aircraft Co., Inc., Long Beach, CA.), Chet J. Dominik (Douglas Aircraft Co., Inc., Long Beach, CA.), and Robert J. McGhee *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 13 p (For primary document see N93-27427 10-02)
Avail: CASI HC A03/MF A04

Experimental studies were conducted to assess Reynolds and Mach number effects on a supercritical multielement airfoil. The airfoil is representative of the stall-critical station of an advanced transport wing design. The experimental work was conducted as part of a cooperative program between the Douglas Aircraft Company and the NASA LaRC to improve current knowledge of high-lift flows and to develop a validation database with practical geometries/conditions for emerging computational methods. This paper describes results obtained for both landing and takeoff multielement airfoils (four and three-element configurations) for a variety of Mach/Reynolds number combinations up to flight conditions. Effects on maximum lift are considered for the landing configurations and effects on both lift and drag are reported for the takeoff geometry. The present test results revealed considerable maximum lift effects on the three-element landing configuration for Reynolds number variations and significant Mach number effects on the four-element airfoil. Author (revised)

N93-27447*# Boeing Commercial Airplane Co., Seattle, WA. Aerodynamics Engineering.
QUANTITATIVE THREE-DIMENSIONAL LOW-SPEED WAKE SURVEYS
G. W. Brune *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 13 p (For primary document see N93-27427 10-02)
Avail: CASI HC A03/MF A04

Theoretical and practical aspects of conducting three-dimensional wake measurements in large wind tunnels are reviewed with emphasis on applications in low-speed aerodynamics. Such quantitative wake surveys furnish separate values for the components of drag, such as profile drag and induced drag, but also measure lift without the use of a balance. In addition to global data, details of the wake flowfield as well as spanwise distributions of lift and drag are obtained. The paper demonstrates the value of this measurement technique using data from wake measurements conducted by Boeing on a variety of low-speed configurations including the complex high-lift system of a transport aircraft. Author (revised)

N93-27448*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
FLOW PREDICTION OVER A TRANSPORT MULTI-ELEMENT HIGH-LIFT SYSTEM AND COMPARISON WITH FLIGHT MEASUREMENTS Abstract Only
P. M. H. W. Vijgen (High Technology Corp., Hampton, VA.), J. D. Hardin (North Carolina State Univ., Raleigh.), and L. P. Yip *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 1 p (For primary document see N93-27427 10-02)
Avail: CASI HC A01/MF A04

Accurate prediction of surface-pressure distributions, merging boundary-layers, and separated-flow regions over multi-element high-lift airfoils is required to design advanced high-lift systems for efficient subsonic transport aircraft. The availability of detailed measurements of pressure distributions and both averaged and time-dependent boundary-layer flow parameters at flight Reynolds numbers is critical to evaluate computational methods and to model the turbulence structure for closure of the flow equations. Several detailed wind-tunnel measurements at subscale Reynolds numbers were conducted to obtain detailed flow information including the Reynolds-stress component. As part of a subsonic-transport high-lift research program, flight experiments are conducted using the NASA-Langley B737-100 research aircraft to obtain detailed flow characteristics for support of computational and wind-tunnel efforts. Planned flight measurements include pressure distributions at several spanwise locations, boundary-layer transition and separation locations, surface skin friction, as well as boundary-layer profiles and Reynolds stresses in adverse pressure-gradient flow.
Author (revised)

N93-27449*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ASSESSMENT OF COMPUTATIONAL ISSUES ASSOCIATED WITH ANALYSIS OF HIGH-LIFT SYSTEMS
R. Balasubramanian (Spectrex Corp., Inc., Gloucester, VA.), Kenneth M. Jones, and Edgar G. Waggoner *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 27 p (For primary document see N93-27427 10-02)
Avail: CASI HC A03/MF A04

Thin-layer Navier-Stokes calculations for wing-fuselage configurations from subsonic to hypersonic flow regimes are now possible. However, efficient, accurate solutions for using these codes for two- and three-dimensional high-lift systems have yet to be realized. A brief overview of salient experimental and computational research is presented. An assessment of the state-of-the-art relative to high-lift system analysis and identification of issues related to grid generation and flow physics which are crucial for computational success in this area are also provided. Research in support of the high-lift elements of NASA's High Speed Research and Advanced Subsonic Transport Programs which addresses some of the computational issues is presented. Finally, fruitful areas of concentrated research are identified to accelerate overall progress for high lift system analysis and design. Author (revised)

N93-27450*# United Technologies Research Center, East Hartford, CT.
UNSTEADY TRANSITION MEASUREMENTS ON A PITCHING THREE-DIMENSIONAL WING **c08**
Peter F. Lorber and Franklin O. Carta *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 14 p (For primary document see N93-27427 10-02)
(Contract DAAL03-89-C-0013)
Avail: CASI HC A03/MF A04

Boundary layer transition measurements were made during an experimental study of the aerodynamics of a rectangular wing undergoing unsteady pitching motions. The wing was tested at chordwise Mach numbers between 0.2 and 0.6, at sweep angles of 0, 15, and 30 deg, and for steady state, sinusoidal, and constant pitch rate motions. The model was scaled to represent a full size helicopter rotor blade, with chord Reynolds numbers between 2 and 6 x 10(exp 6). Sixteen surface hot-film gages were located along three spanwise stations: 0.08, 0.27, and 0.70 chords

from the wing tip. Qualitative heat transfer information was obtained to identify the unsteady motion of the point of transition to turbulence. In combination with simultaneous measurements of the unsteady surface pressure distributions, the results illustrate the effects of compressibility, sweep, pitch rate, and proximity to the wing tip on the transition and relaminarization locations. Author (revised)

N93-27451*# Cincinnati Univ., OH. Dept. of Aerospace Engineering and Engineering Mechanics.

INVESTIGATION OF FORCED UNSTEADY SEPARATED FLOWS USING VELOCITY-VORTICITY FORM OF NAVIER-STOKES EQUATIONS c34

K. N. Ghia, U. Ghia, and G. A. Osswald *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 10 p (For primary document see N93-27427 10-02)

Avail: CASI HC A02/MF A04

The phenomenon of forced unsteady separation and eruption of boundary-layer vorticity is a highly-complex, high-Reynolds number flow phenomenon, which abruptly leads to the formation of a dynamic stall vortex as demonstrated earlier by the authors for a NACA 0015 airfoil undergoing constant rate pitch-up motion. This, as well as the results of other researchers, have convincingly demonstrated a complex vortical structure within the state of unsteady separation prior to the evolution of dynamic stall. This phenomenon of vortex eruption, although observed in studying dynamic stall phenomena, is also associated with transition from laminar to turbulence flow and its generic nature has been stressed by many researchers including the present investigators. An unsteady Navier-Stokes (NS) analysis is developed for arbitrarily maneuvering bodies using velocity-vorticity variables; this formulation is nearly form-invariant under a generalized non-inertial coordinate transformation. A fully-implicit uniformly second-order accurate method is used, with the nonlinear convective terms approximated using a biased third-order upwind differencing scheme to be able to simulate higher-Re flows. No explicit artificial dissipation is added. The numerical method is fully vectorized and currently achieves a computational index of 7 micro-seconds per time step per mesh point, using a single processor on a CRAY Y-MP. The simulation results show that the energetic free shear from the leading edge is responsible for the wall viscous layer to abruptly erupt near the center of the counterclockwise rotating eddy in the unsteady boundary layer. Primary, secondary, tertiary and quaternary vortices have been observed before the dynamic stall vortex evolves and gathers its maximum strength. This study will discuss the simulation results of Reynolds number up to Re = 45,000 and will also discuss the efforts of initial acceleration in a specific maneuver, on the evolution of the stall vortex. Author

N93-27452*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

SOME RECENT APPLICATIONS OF NAVIER-STOKES CODES TO ROTORCRAFT

W. J. McCroskey *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 15 p Prepared in cooperation with Army Aviation Systems Command, Cleveland, OH (For primary document see N93-27427 10-02)

Avail: CASI HC A03/MF A04

Many operational limitations of helicopters and other rotary-wing aircraft are due to nonlinear aerodynamic phenomena incuding unsteady, three-dimensional transonic and separated flow near the surfaces and highly vortical flow in the wakes of rotating blades. Modern computational fluid dynamics (CFD) technology offers new tools to study and simulate these complex flows. However, existing Euler and Navier-Stokes codes have to be modified significantly for rotorcraft applications, and the enormous computational requirements presently limit their use in routine design applications. Nevertheless, the Euler/Navier-Stokes technology is progressing in anticipation of future supercomputers that will enable meaningful calculations to be made for complete rotorcraft configurations. Author (revised)

N93-27453*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

DYNAMIC AIRFOIL STALL INVESTIGATIONS

M. F. Platzer (Naval Postgraduate School, Monterey, CA.), M. S. Chandrasekhara (Naval Postgraduate School, Monterey, CA.), J. A. Ekaterinaris (Naval Postgraduate School, Monterey, CA.), and L. W. Carr (Army Aviation Systems Command, Cleveland, OH.) *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 11 p (For primary document see N93-27427 10-02)

Avail: CASI HC A03/MF A04

Experimental and computational investigations of the dynamic stall phenomenon continue to attract the attention of various research groups in the major aeronautical research laboratories. There are two reasons for this continued research interest. First, the occurrence of dynamic stall on the retreating blade of helicopters imposes a severe performance limitation and thus suggests to search for ways to delay the onset of dynamic stall. Second, the lift enhancement prior to dynamic stall presents an opportunity to achieve enhanced maneuverability of fighter aircraft. A description of the major parameters affecting dynamic stall and lift and an evaluation of research efforts prior to 1988 has been given by Carr. In this paper the authors' recent progress in the development of experimental and computational methods to analyze the dynamic stall phenomena occurring on NACA 0112 airfoils is reviewed. First, the major experimental and computational approaches and results are summarized. This is followed by an assessment of our results and an outlook toward the future. Author (revised)

N93-27454*# David Taylor Research Center, Bethesda, MD.

SIMULTANEOUS MAPPING OF THE UNSTEADY FLOW FIELDS BY PARTICLE DISPLACEMENT VELOCIMETRY (PDV) Abstract Only

Thomas T. Huang, David J. Fry, Han-Lieh Liu, Joseph Katz (Johns Hopkins Univ., Baltimore, MD.), and Thomas C. Fu (Johns Hopkins Univ., Baltimore, MD.) *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 1 p (For primary document see N93-27427 10-02)

Avail: CASI HC A01/MF A04

Current experimental and computational techniques must be improved in order to advance the prediction capability of the longitudinal vortical flows shed by underwater vehicles. The generation, development, and breakdown mechanisms of the shed vortices at high Reynolds numbers are not fully understood. The ability to measure hull separated vortices associated with vehicle maneuvering does not exist at present. The existing point-by-point measurement techniques can only capture approximately the large 'mean' eddies but fail to meet the dynamics of small vortices during the initial stage of generation. A new technique, which offers a previously unavailable capability to measure the unsteady cross-flow distribution in the plane of the laser light sheet, is called Particle Displacement Velocimetry (PDV). PDV consists of illuminating a thin section of the flowfield with a pulsed laser. The water is seeded with microscopic, neutrally buoyant particles containing imbedded fluorescing dye which responds with intense spontaneous fluorescence with the illuminated section. The seeded particles in the vortical flow structure shed by the underwater vehicle are illuminated by the pulse laser and the corresponding particle traces are recorded in a single photographic frame. Two distinct approaches were utilized for determining the velocity distribution from the particle traces. The first method is based on matching the traces of the same particle and measuring the distance between them. The direction of the flow can be identified by keeping one of the pulses longer than the other. The second method is based on selecting a small window within the image and finding the mean shift of all the particles within that region. The computation of the auto-correlation of the intensity distribution within the selected sample window is used to determine the mean displacement of particles. The direction of the flow is identified by varying the intensity of the laser light between pulses. Considerable computational resources are required to compute the auto-correction of the intensity distribution. Parallel processing will be employed to speed up the data reduction. A few examples of measured unsteady vortical flow structures shed by the underwater vehicles will be presented. Author (revised)

N93-27455*# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).

CALCULATION OF FULLY THREE-DIMENSIONAL SEPARATED FLOW WITH AN UNSTEADY VISCOUS-INVISCID INTERACTION METHOD Abstract Only

J. C. LeBalleur and P. Girodroux-Lavigne *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows

1992 1 p (For primary document see N93-27427 10-02)
Avail: CASI HC A01/MF A04

Three previous papers have shown that the viscous inviscid numerical methods were capable of calculating separated turbulent flows. The 'Semi-inverse method' and the models of the first author allow the computation of massive separations, stalled flows, and shock wave-boundary layer interactions, in two-dimensional or quasi-three-dimensional conditions, from low speeds to supersonic speeds. The 'Semi-implicit' method for time-consistent coupling allows for the computation of time-accurate transonic separated flow and buffer computations in two-dimensions. The present paper shows that the viscous-inviscid interaction approach is also able to compute the fully three-dimensional flow separation phenomena. The method is based on a thin-layer approximation of the theory of 'Defect-Formulation' that provides the viscous-inviscid splitting of the Navier-Stokes equations. A parametric analytical modelling of the 3D-turbulent velocity profiles is involved. Numerically, the 3D-velocity profiles are discretized in the normal z-direction and driven by parametric integral 3D-equations in direct or inverse modes in the x-direction. The viscous-inviscid coupling is fully 3D and solved the time-consistency problem with an extension of the 'Semi-implicit' method previously suggested in two-dimensions. A 3D inviscid subroutine with TSP approximation is used. Results are obtained for transonic steady flows over wings with shock-induced transonic separation. The method provides results for highly three-dimensional flow separations, such as induced by a three-dimensional through at the wall of a flat plate. The 3D viscous-inviscid coupling and the 3D model of the velocity field provide three-dimensional instantaneous skin-friction lines whose patterns exhibit the same complex topology as Navier-Stokes solvers, with foci, nodes, and saddle-points.

Author (revised)

N93-27456*# Korea Advanced Inst. of Science and Technology, Seoul (Republic of Korea).

PREDICTION OF AIRFOIL STALL USING NAVIER-STOKES EQUATIONS IN STREAMLINE COORDINATES

D. H. Choi, C. H. Sohn, and C. S. Oh *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 9 p (For primary document see N93-27427 10-02)
Avail: CASI HC A02/MF A04

A Navier-Stokes procedure to calculate the flow about an airfoil at incidence was developed. The parabolized equations are solved in the streamline coordinates generated for an arbitrary airfoil shape using conformal mapping. A modified k-epsilon turbulence model is applied in the entire domain, but the eddy viscosity in the laminar region is suppressed artificially to simulate the region correctly. The procedure was applied to airfoils at various angles of attack, and the results are quite satisfactory for both laminar and turbulent flows. It is shown that the present choice of the coordinate system reduces the error due to numerical diffusion, and that the lift is accurately predicted for a wide range of incidence.

Author (revised)

N93-27457*# Korea Advanced Inst. of Science and Technology, Seoul (Republic of Korea). Dept. of Mechanical Engineering.

DISCRETE-VORTEX SIMULATION OF PULSATING FLOW ON A TURBULENT LEADING-EDGE SEPARATION BUBBLE

Hyung Jin Sung, Jae Wook Rhim, and Masaru Kiya (Hokkaido Univ., Sapporo, Japan.) *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 9 p (For primary document see N93-27427 10-02)
Avail: CASI HC A02/MF A04

Studies are made of the turbulent separation bubble in a two-dimensional semi-infinite blunt plate aligned to a uniform free stream with a pulsating component. The discrete-vortex method is applied to simulate this flow situation because this approach is effective for representing the unsteady motions of the turbulent shear layer and the effect of viscosity near the solid surface. The numerical simulation provides reasonable predictions when compared with the experimental results. A particular frequency with a minimum reattachment is related to the drag reduction. The most effective frequency is dependent on the amplified shedding frequency. The turbulent flow structure is scrutinized. This includes the time-mean and fluctuations of the velocity and the surface pressure, together with correlations between the fluctuating components. A comparison between the pulsating flow and the non-pulsating flow at the particular frequency of the minimum reattachment length of the separation bubble suggests that the large-scale vortical structure is associated with the shedding frequency and the flow instabilities.

Author (revised)

N93-27458*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

A UNIFIED APPROACH FOR NUMERICAL SIMULATION OF VISCOUS COMPRESSIBLE AND INCOMPRESSIBLE FLOWS OVER ADIABATIC AND ISOTHERMAL WALLS **c34**

M. Hafez (California Univ., Davis.), M. Soliman (California Univ., Davis.), and S. White *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 18 p (For primary document see N93-27427 10-02)
Avail: CASI HC A03/MF A04

A new formulation (including the choice of variables, their non-dimensionalization, and the form of the artificial viscosity) is proposed for the numerical solution of the full Navier-Stokes equations for compressible and incompressible flows with heat transfer. With the present approach, the same code can be used for constant as well as variable density flows. The changes of the density due to pressure and temperature variations are identified and it is shown that the low Mach number approximation is a special case. At zero Mach number, the density changes due to the temperature variation are accounted for, mainly through a body force term in the momentum equation. It is also shown that the Boussinesq approximation of the buoyancy effects in an incompressible flow is a special case. To demonstrate the new capability, three examples are tested. Flows in driven cavities with adiabatic and isothermal walls are simulated with the same code as well as incompressible and supersonic flows over a wall with and without a groove. Finally, viscous flow simulations of an oblique shock reflection from a flat plate are shown to be in good agreement with the solutions available in literature.

Author (revised)

N93-27459*# McDonnell Aircraft Co., Saint Louis, MO.

PREDICTION OF VORTEX BREAKDOWN ON A DELTA WING

S. Agrawal, B. A. Robinson, and R. M. Barnett *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 8 p (For primary document see N93-27427 10-02)
Avail: CASI HC A02/MF A04

Recent studies of leading-edge vortex flows with computational fluid dynamics codes using Euler or Navier-Stokes formulations have shown fair agreement with experimental data. These studies have concentrated on simulating the flowfields associated with a sharp-edged flat plate 70 deg delta wing at angles of attack where vortex breakdown or burst is observed over the wing. There are, however, a number of discrepancies between the experimental data and the computed flowfields. The location of vortex breakdown in the computational solutions is seen to differ from the experimental data and to vary with changes in the computational grid and freestream Mach number. There also remain issues as to the validity of steady-state computations for cases which contain regions of unsteady flow, such as in the post-breakdown regions. As a partial response to these questions, a number of laminar Navier-Stokes solutions were examined for the 70 deg delta wing. The computed solutions are compared with an experimental database obtained at low subsonic speeds. The convergence of forces, moments and vortex breakdown locations are also analyzed to determine if the computed flowfields actually reach steady-state conditions.

Author (revised)

N93-27460*# Cranfield Inst. of Tech., Bedford (England). Coll. of Aeronautics.

PLUME EFFECTS ON THE FLOW AROUND A BLUNTED CONE AT HYPERSONIC SPEEDS

P. Atcliffe, D. Kumar, and J. L. Stollery *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 7 p (For primary document see N93-27427 10-02)
(Contract SLS42B/590)
Avail: CASI HC A02/MF A04

Tests at M = 8.2 show that a simulated rocket plume at the base of a blunted cone can cause large areas of separated flow, with dramatic effects on the heat transfer rate distribution. The plume was simulated by solid discs of varying sizes or by an annular jet of gas. Flow over the cone without a plume is fully laminar and attached. Using a large disc, the boundary layer is laminar at separation at the test Reynolds number.

Transition occurs along the separated shear layer and the boundary layer quickly becomes turbulent. The reduction in heat transfer associated with a laminar separated region is followed by rising values as transition occurs and the heat transfer rates towards the rear of the cone substantially exceed the values obtained without a plume. With the annular jet or a small disc, separation occurs much further aft, so that heat transfer rates at the front of the cone are comparable with those found without a plume. Downstream of separation the shear layer now remains laminar and the heat transfer rates to the surface are significantly lower than the attached flow values. Author (revised)

N93-27461*# California Univ., Davis. Dept. of Mechanical and Aeronautical Engineering.

COMBINED FORCED AND FREE CONVECTION IN A CURVED DUCT **c34**

Clement G. Yam and Harry A. Dwyer *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 14 p (For primary document see N93-27427 10-02)

Avail: CASI HC A03/MF A04

The purpose of this study is to investigate the flow and heat transfer characteristics of a combined forced and free convection flow in a curved duct. Solutions are obtained by solving the low Mach number model of the Navier-Stokes equation using a control volume method. The finite-volume method was developed with the use of a predictor-corrector numerical scheme and some new variations of the classical projection method. Solutions indicated that the existence of a buoyancy force has changed the entire flow structure inside a curved duct. Reversed flow at both inner and outer bend is observed. For moderate Reynolds number, the upstream section of the duct was significantly influenced by the free convection processes. In general, heat transfer is strong at the inner bend of the beginning of the heated section and at the outer bend on the last half of the heated section. The maximum velocity location is strongly influenced by the combined effects of buoyancy and centrifugal forces. A strong buoyancy force can reduce the strength of the secondary flow where it plays an important role in mixing. Author (revised)

N93-27462*# Centre d'Etudes et de Recherches, Toulouse (France). Dept. Aerothermodynamique.

INVESTIGATIONS ON ENTROPY LAYER ALONG HYPERSONIC HYPERBOLOIDS USING A DEFECT BOUNDARY LAYER

J. P. Brazier, B. Aupoix, and J. Cousteix *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 12 p (For primary document see N93-27427 10-02)

Avail: CASI HC A03/MF A04

A defect approach coupled with matched asymptotic expansions is used to derive a new set of boundary layer equations. This method ensures a smooth matching of the boundary layer with the inviscid solution. These equations are solved to calculate boundary layers over hypersonic blunt bodies involving the entropy gradient effect. Systematic comparisons are made for both axisymmetric and plane flows in several cases with different Mach and Reynolds numbers. After a brief survey of the entropy layer characteristics, the defect boundary layer results are compared with standard boundary layer and full Navier-Stokes solutions. The entropy gradient effects are found to be more important in the axisymmetric case than in the plane one. The wall temperature has a great influence on the results through the displacement effect. Good predictions can be obtained with the defect approach over a cold wall in the nose region, with a first order solution. However, the defect approach gives less accurate results far from the nose on axisymmetric bodies because of the thinning of the entropy layer. Author

N93-27463*# Cincinnati Univ., OH. Dept. of Aerospace Engineering and Engineering Mechanics.

ADAPTIVE MULTIGRID DOMAIN DECOMPOSITION SOLUTIONS FOR VISCOUS INTERACTING FLOWS **c34**

Stanley G. Rubin and Kumar Srinivasan *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 12 p (For primary document see N93-27427 10-02)

(Grants NAG3-397; AF-AFOSR-0096-90)

Avail: CASI HC A03/MF A04

Several viscous incompressible flows with strong pressure interaction and/or axial flow reversal are considered with an adaptive multigrid domain decomposition procedure. Specific examples include the triple deck structure surrounding the trailing edge of a flat plate, the flow recirculation in a trough geometry, and the flow in a rearward facing step channel. For the latter case, there are multiple recirculation zones, of different character, for laminar and turbulent flow conditions. A pressure-based form of flux-vector splitting is applied to the Navier-Stokes equations, which are represented by an implicit lowest-order reduced Navier-Stokes (RNS) system and a purely diffusive, higher-order, deferred-corrector. A trapezoidal or box-like form of discretization insures that all mass conservation properties are satisfied at interfacial and outflow boundaries, even for this primitive-variable, non-staggered grid computation. Author (revised)

N93-27464*# Naval Oceanographic Office, Bay Saint Louis, MS.

ADAPTIVE EAGLE DYNAMIC SOLUTION ADAPTATION AND GRID QUALITY ENHANCEMENT

Phu Vinh Luong, J. F. Thompson (Mississippi State Univ., Mississippi State.), B. Gatlin (Mississippi State Univ., Mississippi State.), C. W. Mastin (Mississippi State Univ., Mississippi State.), and H. J. Kim (Mississippi State Univ., Mississippi State.) *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 13 p (For primary document see N93-27427 10-02)

(Contracts NAS8-36949; F08635-89-C-0209)

Avail: CASI HC A03/MF A04

In the effort described here, the elliptic grid generation procedure in the EAGLE grid code was separated from the main code into a subroutine, and a new subroutine which evaluates several grid quality measures at each grid point was added. The elliptic grid routine can now be called, either by a computational fluid dynamics (CFD) code to generate a new adaptive grid based on flow variables and quality measures through multiple adaptation, or by the EAGLE main code to generate a grid based on quality measure variables through static adaptation. Arrays of flow variables can be read into the EAGLE grid code for use in static adaptation as well. These major changes in the EAGLE adaptive grid system make it easier to convert any CFD code that operates on a block-structured grid (or single-block grid) into a multiple adaptive code. Author (revised)

N93-27465*# National Aerospace Lab., Amsterdam (Netherlands). Informatics Div.

A ROBUST QUASI-SIMULTANEOUS INTERACTION METHOD FOR A FULL POTENTIAL FLOW WITH A BOUNDARY LAYER WITH APPLICATION TO WING/BODY CONFIGURATIONS **c34**

A. J. vanderWees and J. vanMuijden *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 13 p (For primary document see N93-27427 10-02)

(Contract NIVR-01802-N)

Avail: CASI HC A03/MF A04

The MATRICS flow solver calculates the inviscid transonic potential flow about a wing/body semi-configuration. At present, work is in progress to extend MATRICS to take viscous effects into account through coupling with a boundary layer solver. This solver, MATRICS-V, is based on robust calculation methods for the boundary layer, the outer wing flow and their interaction. MATRICS-V is intended for (inverse) design purposes. The boundary layer and wake are based on an integral formulation of the unsteady first order boundary layer equations, the inviscid method is the existing MATRICS potential flow solver, and the interaction algorithm is of the quasi-simultaneous type. The paper gives a progress report on the coupled potential-flow boundary-layer method for transonic wing/body configurations. Author (revised)

N93-27466*# Iowa Univ., Iowa City. Inst. of Hydraulic Research.

SHIP VISCOUS FLOW: A REPORT ON THE 1990 SSPA-IIHR WORKSHOP **c34**

Virendra C. Patel and Lars Larsson (Chalmers Univ. of Technology, Goeteborg, Sweden.) *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 15 p Sponsored in part by Swedish National Board for Technical Development (For primary document see N93-27427 10-02)

(Contract N00014-89-J-1670)

Avail: CASI HC A03/MF A04

To assess the state of the art in ship viscous flow computation a Workshop was organized in 1990 by three organizations: SSPA Maritime Consulting AB, Chalmers University of Technology, and the Iowa Institute

of Hydraulic Research. Two test cases were specified by the organizers and sent out to all interested research groups, which were asked to submit results in a prescribed format. In September 1990 a meeting was held at Chalmers University of Technology. All results had then been collected and presented in a common format, and the theories based on responses to a questionnaire sent out earlier. During the meeting, each research group was first given the opportunity to briefly introduce their method and results. Thereafter, a considerable time was spent on general discussions on the performance of the different methods considering the differences in the underlying theories. Specific items that were addressed were grid generation, governing equations, boundary conditions, turbulence modelling, and numerical methods. Practical aspects of the results, for instance from the point of view of propeller design, were also discussed. The Workshop Proceedings contain a description of the participating methods, and the results of both test cases. In the present paper, a summary of the Workshop and its results is presented. Author (revised)

N93-27467*# Centre d'Etudes et de Recherches, Toulouse (France).
THREE-DIMENSIONAL BOUNDARY LAYER CALCULATION BY A CHARACTERISTIC METHOD **c34**
R. Houdeville *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 11 p (For primary document see N93-27427 10-02)
Avail: CASI HC A03/MF A04

A numerical method for solving the three-dimensional boundary layer equations for bodies of arbitrary shape is presented. In laminar flows, the application domain extends from incompressible to hypersonic flows with the assumption of chemical equilibrium. For turbulent boundary layers, the application domain is limited by the validity of the mixing length model used. In order to respect the hyperbolic nature of the equations reduced to first order partial derivative terms, the momentum equations are discretized along the local streamlines using of the osculator tangent plane at each node of the body fitted coordinate system. With this original approach, it is possible to overcome the use of the generalized coordinates, and therefore, it is not necessary to impose an extra hypothesis about the regularity of the mesh in which the boundary conditions are given. By doing so, it is possible to limit, and sometimes to suppress, the pre-treatment of the data coming from an inviscid calculation. Although the proposed scheme is only semi-implicit, the method remains numerically very efficient. Author (revised)

N93-27468*# Boeing Commercial Airplane Co., Seattle, WA.
TOWARDS INDUSTRIAL-STRENGTH NAVIER-STOKES CODES **c34**
Wen-Huei Jou, Laurence B. Wigton, and Steven R. Allmaras *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 12 p (For primary document see N93-27427 10-02)
Avail: CASI HC A03/MF A04

In this paper we discuss our experiences with Navier-Stokes (NS) codes using central differencing (CD) and scalar artificial dissipation (SAD). The NS-CDSAD codes have been developed by several researchers. Our results confirm that for typical commercial transport wing and wing/body configurations flying at transonic conditions with all turbulent boundary layers, NS-CDSAD codes, when used with the Johnson-King turbulence model, are capable of computing pressure distributions in excellent agreement with experimental data. However, results are not as good when laminar boundary layers are present. Exhaustive 2-D grid refinement studies supported by detailed analysis suggest that the numerical errors associated with SAD severely contaminate the solution in the laminar portion of the boundary layer. It is left as a challenge to the CFD community to find and fix the problems with Navier-Stokes codes and to produce a NS code which converges reliably and properly captures the laminar portion of the boundary layer on a reasonable grid. Author (revised)

N93-27955# Army Research Lab., Adelphi, MD.
NAVIER-STOKES SIMULATION OF VISCOUS, SEPARATED, SUPERSONIC FLOW OVER A PROJECTILE ROTATING BAND Final Report, Nov. 1989 - Nov. 1991
Bernard J. Guidos and James E. Danberg Mar. 1993 51 p
(DA Proj. 1L1-62618-AH-80)
(AD-A263073; ARL-TR-102) Avail: CASI HC A04/MF A01

A numerical simulation is made of the separated, turbulent flow over the rotating band of a projectile-like body at Mach numbers 2.5, 3.0, and 3.5. The simulation is made by solving the thin-layer, compressible, mass-averaged, Navier-Stokes equations using an implicit numerical procedure. Numerical solutions are generated on a body-conforming computational grid which is constructed by adapting the boundary conditions of a grid generation scheme which solves the two-dimensional Poisson equations. The computed surface pressure distributions are compared to existing supersonic wind tunnel measurements. An evaluation is made of the accuracy and suitability of the numerical approach, and recommendations are made for the direction of future investigation. DTIC

N93-28070*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EFFECT OF PYLON CROSS-SECTIONAL GEOMETRIES ON PROPULSION INTEGRATION FOR A LOW-WING TRANSPORT
Anthony M. Ingraldi, Dinesh A. Naik (Vigyan Research Associates, Inc., Hampton, VA.), and Odis C. Pendergraft, Jr. Washington Jun. 1993 66 p
(RTOP 535-03-10-01)
(NASA-TP-3333; L-17149; NAS 1.60:3333) Avail: CASI HC A04/MF A01

An experimental program was conducted in the Langley 16-Foot Transonic Tunnel to evaluate the performance effects of various types of pylons on a 1/17th-scale, low-wing transport model. The model wing was designed for cruise at a Mach number of 0.77 and a lift coefficient of 0.55. The pylons were tested at two wing semispan locations over a range of toe-in angles. The effects of toe-in angle were found to be minimal, but the variation in geometry had a more pronounced effect on the lift characteristics of the model. A pylon whose maximum thickness occurred at the wing trailing edge, known as a compression pylon, proved to be the best choice in terms of retaining the flow characteristics of the wing without pylons. Practical considerations such as structural viability may necessitate modification of the compression pylon concept in order to take advantage of its apparent benefits. Author

N93-28078 Michigan Univ., Ann Arbor.
AXISYMMETRIC VORTEX SHEET ROLL-UP Ph.D. Thesis
Monika Nitsche 1992 89 p
Avail: Univ. Microfilms Order No. DA9308412

This thesis presents a numerical study of axisymmetric vortex sheet roll-up applied to vortex ring formation. The calculations are performed using a vortex blob method which resolves spiral vortex sheet roll-up. A convergence study with respect to the smoothing parameter is performed, and detailed information about the vortex sheet is obtained. The first problem studied is the evolution of an initially flat circular vortex sheet obtained by giving a disk immersed in ideal fluid an impulse and then removing it from the fluid. For a short time, the computed axisymmetric vortex sheet rolls up and obeys 2-d similarity theory in a moving frame of reference. For longer times, the computed solution approximates a steady propagating vortex ring with vorticity concentrated in a core, in good agreement with a symmetric core model proposed by an earlier researcher. A slight asymmetry in the computed vorticity distribution is responsible for a small deviation of the vortex ring radius and translation velocity from the theoretical results of others. The second problem studied is vortex ring formation at the edge of a circular tube due to the motion of a piston which ejects fluid from the tube. An earlier experiment is simulated numerically using a vortex blob model which incorporates vortex sheet separation at a sharp edge. Good agreement between computation and experiment is found for the sheet shape and the vortex ring trajectory. Except in an initial time period, during which viscous effects, are dominant in the experiment, the computed and experimental circulation shedding rates agree reasonably well. Experiments show that the vortex ring trajectory does not obey 2-d similarity theory predictions over long times. The present computations confirm this experimental observation and clarify previous explanations proposed for the absence of self-similarity. Dissert. Abstr.

N93-28251 Boston Univ., MA.
THE ONSET OF VORTEX TURBULENCE Ph.D. Thesis
Greg Huber 1993 110 p
Avail: Univ. Microfilms Order No. DA9309755

The onset of turbulence in two-dimensional, excitable media close to a global Hopf bifurcation is investigated. There one finds that the turbulence

is associated with the appearance of topological point defects (vortices). A discrete form of the complex Ginzburg-Landau equation is used to explore the dynamics. Linear stability analysis of the complex Ginzburg-Landau equation indicates in what regions of parameter space the global, homogeneous solution is stable. However, in general the system does not asymptotically settle into this homogeneous state, rather it finds a many-vortex state. This can be either a 'frozen' state of stationary vortices, or a highly turbulent state with vortex-antivortex creation and annihilation. These states are related to the dynamics of the vortex statistics, as computed numerically. A phase diagram, based on the numerical simulations, is presented. Transient turbulence, near the transition line that separates the frozen states and the turbulent states, is discovered. These transients are identified as metastable states having a well-defined vortex density. Just below the transition to turbulence, the metastable states break down through the nucleation and growth of single-vortex droplets, leading to a finite-density frozen state. The lifetime of the metastable state is found to depend on the distance to the transition line. A relation between the nucleation time and droplet radius is derived, and their dependence on the distance to the turbulence transition is found. Dissert. Abstr.

N93-28440# Institut National de Recherche d'Informatique et d'Automatique, Valbonne (France). Programme 4: Robotique, Image et Vision.

HOMENTHALPIC-FLOW APPROACH FOR HYPERSONIC INVISCID NON-EQUILIBRIUM FLOWS

Marie-Claude Ciccoli and Jean-Antoine Desideri Apr. 1992 36 p
(INRIA-RR-1652; ETN-93-93899) Avail: CASI HC A03/MF A01

Two different methods for the numerical simulation of steady, inviscid, nonequilibrium reactive flow governed by Euler equations augmented by a five species seventeen reaction finite rate dissociation model are studied. The employed approximations are based on a conservative mixed finite volume/finite element upwind formulation. The study concentrates on the efficiency of the pseudo time integration methods as iterative algorithms. The iterative properties of the basic method are demonstrated by various computations of the flow fields around blunt bodies. In particular, the effect of varying the global Damkhoeler number (i.e. the size of geometry) is illustrated. A variant of the basic method is proposed. For steady (external) flows with uniform free stream, the total enthalpy is known to be constant throughout the domain. Hence, an algorithm which conserves this quantity was implemented in which the energy equation (in differential form) is not solved but replaced by its (algebraic) first integral. The extension of existing Flux Vector Splittings (FVS) to this context where one less partial differential equation is solved and one algebraic contraint is enforced, is examined. The FVS is demonstrated to be proper, and the efficiency of the proposed approach is assessed by numerical experiments for first and second order approximation schemes. ESA

N93-28449*# West Virginia Univ., Morgantown. Dept. of Mechanical and Aerospace Engineering.

THE GROUND VORTEX FLOW FIELD ASSOCIATED WITH A JET IN A CROSS FLOW IMPINGING ON A GROUND PLANE FOR UNIFORM AND ANNULAR TURBULENT AXISYMMETRIC JETS M.S. Thesis

William M. Cavage and John M. Kuhlman Washington May 1993 162 p
(Grant NAG1-1245; RTOP 505-59-30-02)
(NASA-CR-4513; NAS 1.26:4513) Avail: CASI HC A08/MF A02

An experimental study was conducted of the impingement of a single circular jet on a ground plane in a cross flow. This geometry is a simplified model of the interaction of propulsive jet exhaust from a V/STOL aircraft with the ground in forward flight. Jets were oriented normal to the cross flow and ground plane. Jet size, cross flow-to-jet velocity ratio, ground plane-to-jet board spacing, and jet exit turbulence level and mean velocity profile shape were all varied to determine their effects on the size of the ground vortex interaction region which forms on the ground plane, using smoke injection into the jet. Three component laser Doppler velocimeter measurements were made with a commercial three color system for the case of a uniform jet with exit spacing equal to 5.5 diameters and cross flow-to-jet velocity ratio equal to 0.11. The flow visualization data compared well for equivalent runs of the same nondimensional jet exit spacing and the same velocity ratio for different diameter nozzles, except at very low velocity ratios and for the larger nozzle, where tunnel blockage became significant. Variation of observed ground vortex size with cross flow-to-jet velocity ratio was consistent with previous studies. Observed effects of jet size and ground plane-to-jet board spacing were relatively small. Jet exit turbulence level effects were also small. However, an annular jet with a low velocity central core was found to have a significantly smaller ground vortex than an equivalent uniform jet at the same values of cross flow-to-jet velocity ratio and jet exit-to-ground plane spacing. This may suggest a means of altering ground vortex behavior somewhat, and points out the importance of proper simulation of jet exit velocity conditions. LV data indicated unsteady turbulence levels in the ground vortex in excess of 70 percent. Author (revised)

N93-27167 Princeton Univ., NJ. Dept. of Mechanical and Aerospace Engineering.

HYPERSONICS REVISITED

Seymour M. Bogdonoff *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 1-9 (For primary document see N93-27166 10-01)
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N93-27212 Rafael Armament Development Authority, Haifa (Israel).

AIRFOIL STABILITY IN TURBULENT FLOW

A. Sternberg *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 385-391 (For primary document see N93-27166 10-01)
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N93-27214 Tel-Aviv Univ. (Israel).

TOWARDS AN ANALYTICAL TREATMENT OF THE AEROLASTIC PROBLEM OF A CIRCULAR WING

A. Hauptman and T. Miloh *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 398-403 (For primary document see N93-27166 10-01)
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N93-27218 Technion - Israel Inst. of Tech., Haifa. Faculty of Aerospace Engineering.

LEADING EDGE VORTICES IN A CHORDWISE PERIODIC FLOW

M. Amitay, J. Er-Al, and A. Seginer *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 427-438 (For primary document see N93-27166 10-01)
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N93-27220 National Research Council of Canada, Ottawa (Ontario). Inst. for Aerospace Research.

EFFECT OF VORTEX BEHAVIOR ON LOADS ACTING ON A 65 DEG DELTA WING OSCILLATING IN ROLL AT HIGH INCIDENCE

E. S. Hanff and X. Z. Huang *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 446-458 (For primary document see N93-27166 10-01)
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N93-27221 Technion - Israel Inst. of Tech., Haifa. Faculty of Aerospace Engineering.

ANALYSIS OF WIND-TUNNEL DATA FOR ELLIPTIC CROSS-SECTIONED FOREBODIES AT MACH NUMBERS 0.4 TO 5.0

Asher Sigal and Gavriel Avital *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 459-466 (For primary document see N93-27166 10-01)
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03 AIR TRANSPORTATION AND SAFETY

Includes passenger and cargo air transport operations; and aircraft accidents.

For related information see also *16 Space Transportation* and *85 Urban Technology and Transportation.*

N93-27033# National Transportation Safety Board, Washington, DC. Office of Research and Engineering.

ANNUAL REVIEW OF AIRCRAFT ACCIDENT DATA: US GENERAL AVIATION CALENDAR YEAR 1989

1989 87 p

(PB93-160687; NTSB/ARG-93/01) Avail: CASI HC A05/MF A01

A statistical compilation and review of general aviation accidents which occurred in 1989 in the United States, its territories and possessions, and in international waters is presented. The accidents reported are all those involving U.S. registered aircraft not conducting operations under 14 CFR 121, 14 CFR 125, 14 CFR 127, or 14 CFR 135. The five sections covered are: all accidents; fatal accidents; serious injury accidents; property damage accidents; and midair collision accidents. Several tables present accident parameters for 1989 accidents only, and each section includes tabulations which present comparative statistics for 1989 and for the five-year period 1984-1988. Author (revised)

N93-27034# National Transportation Safety Board, Washington, DC.

AIRCRAFT ACCIDENT REPORT: TAKEOFF STALL IN ICING CONDITIONS. USAIR FLIGHT 405 FOKKER F-28, N485US, LAGUARDIA AIRPORT, FLUSHING, NEW YORK, 22 MARCH 1992

17 Feb. 1993 129 p

(PB93-910402; NTSB/AAR-93/02) Avail: CASI HC A07/MF A02

The crash of USAir flight 405, a Fokker 28-4000, after an attempted takeoff from runway 13 at LaGuardia Airport, Flushing, New York, on March 22, 1992 is explained. The safety issues focus on the weather, USAir's deicing procedures, industry airframe deicing practices, air traffic control aspects of the flight, USAir's takeoff and preflight procedures, and flightcrew qualifications and training. The airplane's impact with the ground, postaccident survivability, and crash/fire/rescue activities are also discussed. Safety recommendations concerning these issues are addressed to the Federal Aviation Administration, the Port Authority of New York and New Jersey, the Department of Transportation, and the New York City Health and Hospitals Corporation. Author (revised)

N93-27035# National Transportation Safety Board, Washington, DC.

AIRCRAFT ACCIDENT REPORT: CONTROLLED COLLISION WITH TERRAIN GP EXPRESS AIRLINES, INC., FLIGHT 861, A BEECHCRAFT C99, N118GP, ANNISTON, ALABAMA, 8 JUNE 1992

2 Mar. 1993 79 p

(PB93-910403; NTSB/AAR-93/03) Avail: CASI HC A05/MF A01

The controlled collision into terrain of GP Express flight 861, a Beechcraft C99, N118GP, in Anniston, Alabama, on June 8, 1992 is described. The safety issues discussed are, for aircraft operating under 14 CFR Part 135, the importance of adequate preparation and experience of newly hired captains, available approach charts for each pilot, and adherence to specific stabilized approach criteria. The importance of adequate cockpit resource management is also discussed. Recommendations concerning these issues were made to the Federal Aviation Administration. Author (revised)

N93-27076*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

AUTOGENIC-FEEDBACK TRAINING IMPROVES PILOT PERFORMANCE DURING EMERGENCY FLYING CONDITIONS

Michael A. Kellar (Tripler Army Medical Center, Honolulu, HI.), Raymond A. Folen (Tripler Army Medical Center, Honolulu, HI.), Patricia S. Cowings, William B. Toscano (California Univ., San Francisco.), and Glen L. Hisert (Coast Guard, Barbers Point, HI.) Mar. 1993 12 p

(RTOP 199-70-12-14)

(NASA-TM-104005; A-93046; NAS 1.15:104005) Avail: CASI HC A03/MF A01

Studies have shown that autonomous mode behavior is one cause of aircraft fatalities due to pilot error. In such cases, the pilot is in a high state of psychological and physiological arousal and tends to focus on one problem, while ignoring more critical information. The effect of training in physiological self-recognition and regulation, as a means of improving crew cockpit performance was examined. Seventeen pilots were assigned to the treatment and control groups matched for accumulated flight hours. The treatment group comprised four pilots of HC-130 Hercules aircraft and four HH-65 Dolphin helicopter pilots; the control group comprised three pilots of HC-130's and six Dolphin helicopter pilots. During an initial flight physiological data were recorded for each crewmember and individual crew performance and rated by an instructor pilot. Eight crewmembers were then taught to regulate their own physiological response levels using Autogenic-Feedback Training (AFT). The remaining subjects received no training. During a second flight, treatment subjects showed significant improvement in performance, while controls did not improve. The results indicate that AFT management of high states of physiological arousal may improve pilot performance during emergency flying conditions.

Author (revised)

N93-27252# Illinois Univ., Urbana-Champaign. Dept. of Aeronautical and Astronautical Engineering.

EFFECT OF UNDERWING FROST ON TRANSPORT AIRCRAFT TAKEOFF PERFORMANCE

Michael B. Bragg and Douglas C. Heinrich Feb. 1993 97 p

(Contract DTA03-92-C-00013)

(DOT/FAA/CT-TN93/9) Avail: CASI HC A05/MF A02

The effect of underwing frost on transport aircraft takeoff and climb performance was studied. Underwing frost occurs when the lower surface of the wing is cooled by cold-soaked fuel in the wing tanks and frost accretes prior to takeoff. A two-dimensional test was performed in the NASA Langley Low Turbulence Pressure Tunnel on a typical high-lift airfoil with leading-edge slats and trailing-edge flaps. Frost was simulated on the lower surface using distributed roughness particles. The test was conducted at a Mach number of 0.2 and chord Reynolds numbers from 5 to 16 million. The effects of the frost were generally small with the largest effects occurring for the slat open case with the frost starting at 12 percent chord. In this situation the frost actually contaminated the upper surface boundary layer. The 2-D data were extrapolated to 3-D for a typical twin-jet and four-jet aircraft. Drag increases were converted into weight penalties to maintain clean aircraft climb angles, and maximum lift penalties were presented as stall speed changes or weight penalties to maintain clean aircraft stall speeds. The largest weight penalties were incurred to maintain the clean stall speed, but all effects were small considering the conservative assumptions made in the analysis.

Author (revised)

N93-27267*# Boeing Defense and Space Group, Seattle, WA. Military Airplanes Div.

THREE-DIMENSIONAL WATER DROPLET TRAJECTORY CODE VALIDATION USING AN ECS INLET GEOMETRY Final Report

Marlin D. Breer and Mark P. Goodman May 1993 325 p

(Contract NAS3-25820; RTOP 505-62-00)

(NASA-CR-191097; E-7853; NAS 1.26:191097) Avail: CASI HC A14/MF A03

A task was completed under NASA contract, the purpose of which was to validate a three-dimensional particle trajectory code with existing test data obtained from the Icing Research Tunnel at NASA-LeRC. The geometry analyzed was a flush-mounted environmental control system (ECS) inlet. Results of the study indicated good overall agreement between analytical predictions and wind tunnel test results at most flight conditions. Difficulties were encountered when predicting impingement characteristics of the droplets less than or equal to 13.5 microns in diameter. This difficulty was corrected to some degree by modifications to a module of the particle trajectory code; however, additional modifications will be required to accurately predict impingement characteristics of smaller droplets.

Author (revised)

N93-27269# Galaxy Scientific Corp., Pleasantville, NJ.

AIRCRAFT ICE DETECTORS AND RELATED TECHNOLOGIES FOR ONGROUND AND INFLIGHT APPLICATIONS Final Report

Gregory A. Hoover Apr. 1993 52 p

(Contract DTFA03-89-C-00043)

(DOT/FAA/CT-92/27) Avail: CASI HC A04/MF A01

This report describes a number of ice detection systems and identifies companies which produce ice detection systems. Twenty-two companies

were contacted for this report. Of these companies, 16 satisfied the criteria for inclusion in the report. Systems described in this report include inflight, onground, combined inflight and onground, and related technologies. Each technology category features a 'Promising Technologies' section. In these sections, future ice detections systems are discussed. Author (revised)

N93-28055# Federal Aviation Administration, Atlantic City, NJ.
VENTILATION EFFECTS ON SMOKE AND TEMPERATURE IN AN AIRCRAFT CABIN QUARTER-SCALE MODEL Final Report
Allan Abramowitz and Franklin Fann Mar. 1993 35 p
(DOT/FAA/CT-89/25) Avail: CASI HC A03/MF A01

Fire tests were conducted on a quarter-scale model of an aircraft cabin to determine ventilation effects on temperature and smoke. The ventilation rates were varied between 1 1/4 and 2 1/2 minutes of time for an air exchange (quarter scale). The data indicate that there were no significant changes in the cabin temperatures and in the quantity of heat being removed from the cabin by changing ventilation rates. The increased flows tended to redistribute small quantities of smoke within the cabin and out the exhaust. Author (revised)

N93-28206# Technische Univ., Brunswick (Germany). Fakultaet fuer Maschinenbau und Elektrotechnik.
PROTECTION OF TAXIING TRAFFIC IN AIRPORTS THROUGH MODE S SECONDARY RADAR TECHNOLOGY Ph.D. Thesis [SICHERUNG DES ROLLVERKEHRS AUF FLUGHAEFEN DURCH MODE S SEKUNDAERRADARTECHNIKEN]
Wolfgang Detlefsen 1992 154 p In GERMAN
(ETN-93-93455) Avail: CASI HC A08/MF A02

The implementation possibilities of taxiing traffic protection systems are examined with particular consideration to a system based on mode S. Mode S was chosen because of the opportunity of data identification and transfer with tools corresponding to IACO (International Civil Aviation Organization) standards. It was proposed to build a locating and identification system by phase difference detection. An experimental mode S installation was developed for allowing phase and transmission measurements on airports and to be later used as an experimental localization system according to the trilateration process. Signal processing capability was tested in Frankfurt Airport (Germany), and the whole system was tested in Hanover Airport. It is remarked that pilot orientation on the runway can be improved by graphical information such as runway maps. Influence of perturbations on location and data transfer was studied, such as multichannel signal propagation and radio emissions. ESA

04 AIRCRAFT COMMUNICATIONS AND NAVIGATION

Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.

For related information see also *17 Space Communications, Spacecraft Communications, Command and Tracking* and *Communications and Radar.*

N93-27017# Federal Aviation Administration, Atlantic City, NJ.
THE ILS MATHEMATICAL MODELING STUDY OF THE RUNWAY 10 ILS LOCALIZER AT LUIS MUNOZ MARIN INTERNATIONAL AIRPORT, SAN JUAN, PUERTO RICO
James D. Rambone Apr. 1993 23 p
(Contract FAA-T0603-S)
(DOT/FAA/CT-TN93/10) Avail: CASI HC A03/MF A01

This Technical Note describes the Instrument Landing System (ILS) math modeling performed by the Federal Aviation Administration (FAA) Technical Center at the request of the Southern Region. Computed localizer data are presented showing the effects of several structures on the performance of an ILS localizer serving runway 10 at the Luis Munoz Marin International Airport. The facility currently employs an 8-element log periodic dipole (LPD) antenna array which has been restricted and unusable from the middle marker inbound. A 14-element, self-clearing, LPD and a 14/6, dual-frequency, LPD localizer antenna system were modeled at the localizer site as possible replacement antennas. Modeled course structure results indicate that Category 1 localizer performance should be obtained with either of these antenna systems installed at the existing localizer site. Computed clearance orbit results for both replacement antenna systems indicate satisfactory linearity, course crossover, and signal clearance levels. Author

N93-27544# Massachusetts Inst. of Tech., Lexington.
GPS L1-L2 BIAS DETERMINATION
E. M. Gaposchkin and A. J. Coster 12 Jan. 1993 38 p
(Contract F19628-90-C-0002)
(AD-A262141; TR-971; ESC-TR-92-147) Avail: CASI HC A03/MF A01

The GPS satellite L1-L2 bias T(sub gd) is determined using data from a TI-4100 receiver operating at Millstone Hill in Westford, MA. Pseudorange L1-L2 differences are computed. This difference is a measure of the total electron content (TEC) path delay along the line of sight plus the L1-L2 satellite and receiver bias. The difference of two measurements at the same time and satellite position cancels the TEC path delay and possible receiver bias and is a measure of the difference in satellite bias of the two satellites: Sv(a)L1-L2 - Sv(b)L1-L2. Such direct measurements are not often available. Therefore, measurements at the same time are converted to 'zenith' TEC values using a mapping function. These differences are used in a least squares solution to determine the difference in bias between GPS satellites. Individual bias differences are obtained with an accuracy of 0.1 ns (0.285 TEC units) or better. By choosing one satellite as the reference, the individual satellite biases can also be obtained. The stability of each satellite bias is also estimated by examining a time series of the differences. DTIC

N93-27925# Operational Test and Evaluation Force, Norfolk, VA.
FOLLOW-ON OPERATIONAL TEST AND EVALUATION OF THE NAVSTAR GLOBAL POSITIONING SYSTEM AIR INTEGRATION/INSTALLATION PROGRAM
Tony Boex 22 Feb. 1993 8 p
(AD-A263067; OPNAV-3960-12) Avail: CASI HC A02/MF A01

This is a report of COMOPTEVFOR's first phase of follow-on operational test and evaluation of the Global Positioning System (GPS) as installed in the ES-3A. The purpose of the evaluation was to determine the reliability, maintainability, and availability of the AN/ARN-151 GPS User Equipment, as installed in the ES-3A, in an aircraft carrier environment. The GPS user equipment (UE) is determined to be operationally suitable. Approval for extension of application to platforms which require catapult launches and arrested landings is recommended. DTIC

N93-28241# Massachusetts Inst. of Tech., Cambridge. Dept. of Earth Atmospheric and Planetary Sciences.
GPS MEASUREMENTS AT VANDENBERG, AFB Annual Technical Report, 1 Sep. 1991 - 14 Oct. 1992
Robert King 22 Feb. 1993 15 p
(Grant AF-AFOSR-0339-90)
(AD-A262280; AFOSR-93-0164TR) Avail: CASI HC A03/MF A01

Recent geological and geodetic studies have suggested that the region surrounding Vandenberg AFB is undergoing active crustal deformation, with important implications for both the geodetic stability and the seismogenic potential of the Western Test Range (WTR). Part of the evidence for significant deformation was obtained from GPS measurements over a broad area of central and southern California, which we carried out in cooperation with other university and government scientists from 1987 through 1991. Although useful in defining the regional tectonic setting, these measurements are of insufficient spatial and temporal density to answer many important questions about the seismogenic potential of Vandenberg. The sites observed in the March 1992 survey are given, and a map of the enlarged network is shown. Four new sites (CASM, FAARF, RDRK, and FIGP) were established on or bridging three of the four major anticlines that cut the Santa Maria Basin. Our primary scientific goal is to localize the measured deformation on one or more of these structures. One of the new sites (SOAP) provides a more stable anchor for that part of our network south of the Santa Ynez River Fault. Three other sites occupied for the first time (ARG3, VINA, VANP), as well as two previously occupied (ALVA, VNDN), are existing DMA sites near the south Base PGGA site (VNDP). This small sub-network provides a means to monitor the local stability of the three test sites (VAND, VNDN, and VNDP) that have been or will be used for long-term monitoring of deformation. The two-day occupation of the South

Base sub-network also provided us the opportunity to study more carefully the effects of atmospheric water vapor on GPS measurements. DTIC

N93-27178 Rafael Armament Development Authority, Haifa (Israel).
INFORMATION-BASED CRITERIA OF TERRAIN NAVIGABILITY. PART 1: DATA-BASE ANALYSIS
S. Faibish and A. Yavnai *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 98-106 (For primary document see N93-27166 10-01)
Copyright Avail: Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel

N93-27207 Technion - Israel Inst. of Tech., Haifa. Faculty of Aerospace Engineering.
GUIDANCE LAW SYNTHESIS AND EVALUATION FOR A STRAPDOWN SEEKER APPLICATION
Michael Wetzler and Josef Shinar *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 344-354 (For primary document see N93-27166 10-01)
Copyright Avail: Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel

05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

For related information see also *18 Spacecraft Design, Testing and Performance* and *39 Structural Mechanics*.For land transportation vehicles see *85 Urban Technology and Transportation.*

N93-27089*# Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Aerospace and Ocean Engineering.
ADJOINT METHODS FOR AERODYNAMIC WING DESIGN Semiannual Progress Report
Bernard Grossman May 1993 18 p
(Grant NAG1-1466)
(NASA-CR-193086; NAS 1.26:193086; NLPN92-737) Avail: CASI HC A03/MF A01

A model inverse design problem is used to investigate the effect of flow discontinuities on the optimization process. The optimization involves finding the cross-sectional area distribution of a duct that produces velocities that closely match a targeted velocity distribution. Quasi-one-dimensional flow theory is used, and the target is chosen to have a shock wave in its distribution. The objective function which quantifies the difference between the targeted and calculated velocity distributions may become non-smooth due to the interaction between the shock and the discretization of the flowfield. This paper offers two techniques to resolve the resulting problems for the optimization algorithms. The first, shock-fitting, involves careful integration of the objective function through the shock wave. The second, coordinate straining with shock penalty, uses a coordinate transformation to align the calculated shock with the target and then adds a penalty proportional to the square of the distance between the shocks. The techniques are tested using several popular sensitivity and optimization methods, including finite-differences, and direct and adjoint discrete sensitivity methods. Two optimization strategies, Gauss-Newton and sequential quadratic programming (SQP), are used to drive the objective function to a minimum. Author

N93-27241*# California Polytechnic State Univ., San Luis Obispo.
ROBUST CROSSFEED DESIGN FOR HOVERING ROTORCRAFT M.S. Thesis
David R. Catapang Apr. 1993 70 p
(Contract NCC2-751)
(NASA-CR-193107; NAS 1.26:193107) Avail: CASI HC A04/MF A01

Control law design for rotorcraft fly-by-wire systems normally attempts to decouple angular responses using fixed-gain crossfeeds. This approach can lead to poor decoupling over the frequency range of pilot inputs and increase the load on the feedback loops. In order to improve the decoupling performance, dynamic crossfeeds may be adopted. Moreover, because of the large changes that occur in rotorcraft dynamics due to small changes about the nominal design condition, especially for near-hovering flight, the crossfeed design must be 'robust.' A new low-order matching method is presented here to design robost crossfeed compensators for multi-input, multi-output (MIMO) systems. The technique identifies degrees-of-freedom that can be decoupled using crossfeeds, given an anticipated set of parameter variations for the range of flight conditions of concern. Cross-coupling is then reduced for degrees-of-freedom that can use crossfeed compensation by minimizing off-axis response magnitude average and variance. Results are presented for the analysis of pitch, roll, yaw, and heave coupling of the UH-60 Black Hawk helicopter in near-hovering flight. Robust crossfeeds are designed that show significant improvement in decoupling performance and robustness over nominal, single design point, compensators. The design method and results are presented in an easily-used graphical format that lends significant physical insight to the design procedure. This plant pre-compensation technique is an appropriate preliminary step to the design of robust feedback control laws for rotorcraft. Author (revised)

N93-27258*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
MULTIDISCIPLINARY DESIGN OPTIMIZATION: AN EMERGING NEW ENGINEERING DISCIPLINE
Jaroslaw Sobieszczanski-Sobieski May 1993 13 p Prepared for presentation at the World Congress on Optimal Design of Structural Systems, Rio De Janeiro, Brazil, 2-6 Aug. 1993
(RTOP 505-63-50)
(NASA-TM-107761; NAS 1.15:107761) Avail: CASI HC A03/MF A01

This paper defines the Multidisciplinary Design Optimization (MDO) as a new field of research endeavor and as an aid in the design of engineering systems. It examines the MDO conceptual components in relation to each other and defines their functions. Author

N93-27547# Naval Postgraduate School, Monterey, CA.
TESTING A WHEELED LANDING GEAR SYSTEM FOR THE TH-57 HELICOPTER M.S. Thesis
Nancy L. Heckman Dec. 1992 173 p
(AD-A262152) Avail: CASI HC A08/MF A02

Using the main gear from a Cessna 182 and the nose gear from a Grumman AAI-B, (patent pending) a comparison with the skid gear currently installed on the TH-57 helicopters was conducted. The initial comparison was done using a structural analysis program, GIFTS, to simultaneously analyze and compare the gear systems. Experimental data was used to verify program results. Experimental testing was conducted for further code validation and analysis of each system's advantages and disadvantages. While the benefits of a wheeled system merit further study, the system analyzed requires modification to eliminate premature failure of the nose wheel attachment tube. DTIC

N93-27692# Army Research Lab., Aberdeen Proving Ground, MD.
ANALYSIS OF THE STATIC AND DYNAMIC RESPONSE OF A T-38 WING AND COMPARISON WITH EXPERIMENTAL DATA Final Report, Aug. 1990 - Nov. 1991
Jong-Ho Woo Mar. 1993 105 p
(DA Proj. 1L1-62618-AH-80)
(AD-A262363; ARL-TR-99) Avail: CASI HC A06/MF A02

This report documents the investigation of a three-dimensional finite element model for calculating the static displacement and dynamic structural response of a T-38 wing and comparison of the analytical results with T-38 wing experimental data. The wing structure is modeled by rod and bar (beam), quadrilateral plate, triangular plate, and shear panel finite elements. The general structural analysis programs MSC/NASTRAN and MSC/PAL2 are used to calculate deflections, natural frequencies, and mode shapes. The wing finite element model yielded excellent agreement between calculated and experimental results for the eight loading conditions studied. The methodology developed in this study is expected to provide a valuable tool for the static aeroelastic response and dynamic analysis of wing structures in conjunction with aircraft ballistic vulnerability assessments. DTIC

N93-27694# Air Force Systems Command, Wright-Patterson AFB, OH. Foreign Aerospace Science and Technology Center.
COMPUTATIONAL METHOD IN OPTIMAL BENDING-TWISTING COMPREHENSIVE DESIGN OF WINGS OF SUBSONIC AND SUPERSONIC AIRCRAFT
Liu Dehua and Huang Changyou 25 Feb. 1993 19 p Transl. into ENGLISH from Kongqidonglixue Xuebao (China), vol. 7, no. 2, Jun. 1989 p 192-198
(AD-A262374; FASTC-ID(RS)T-0826-92) Avail: CASI HC A03/MF A01

The paper presents a computational method for the optimal bending-twisting design of wings of subsonic and supersonic aircraft; a method for obtaining the finite fundamental solution is applied. By selecting a specific design point (M number and C(sub L)), the design of wings to withstand bending and twisting can be carried out. The goal is to reduce lift-related drag. On this technical basis, the aerodynamic features of these two design points for subsonic and supersonic aircraft are noted in addition to the feasibility of other aircraft performance values applied to its structure. The paper presents the computational results of the optimal bending-twisting design for subsonic and supersonic aircraft, as well as the comprehensive design. As analysis showed, the computational results are rational. DTIC

N93-27168 Lockheed Advanced Development Co., Sunland, CA.
THE DEVELOPMENT OF AIRCRAFT IN THE LOCKHEED SKUNK WORKS FROM 1954 TO 1991
Ben R. Rich *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 10-14 (For primary document see N93-27166 10-01)
Copyright Avail: Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel

N93-27173 Lockheed Advanced Development Co., Burbank, CA.
YF-22A PROTOTYPE ADVANCED TACTICAL FIGHTER DEMONSTRATION/VALIDATION FLIGHT TEST PROGRAM OVERVIEW
David L. Ferguson *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 43-56 (For primary document see N93-27166 10-01)
Copyright Avail: Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel

06 AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

For related information see also *19 Spacecraft Instrumentation* and *35 Instrumentation and Photography.*

N93-28418*# Pennsylvania State Univ., University Park. Dept. of Electrical and Computer Engineering.
A MODEL-BASED APPROACH FOR DETECTION OF OBJECTS IN LOW RESOLUTION PASSIVE MILLIMETER WAVE IMAGES Interim Report, 24 Jan. 1992 - 23 Jan. 1993
Rangachar Kasturi, Yuan-Liang Tang, and Sadashiva Devadiga 1993 26 p
(Grant NAG1-1371)
(NASA-CR-193161; NAS 1.26:193161) Avail: CASI HC A03/MF A01

A model-based vision system to assist the pilots in landing maneuvers under restricted visibility conditions is described. The system was designed to analyze image sequences obtained from a Passive Millimeter Wave (PMMW) imaging system mounted on the aircraft to delineate runways/taxiways, buildings, and other objects on or near runways. PMMW sensors have good response in a foggy atmosphere, but their spatial resolution is very low. However, additional data such as airport model and approximate position and orientation of aircraft are available. These data are exploited to guide our model-based system to locate objects in the low resolution image and generate warning signals to alert the pilots. Also analytical expressions were derived from the accuracy of the camera position estimate obtained by detecting the position of known objects in the image.
Author (revised)

N93-27169 General Dynamics Corp., Fort Worth, TX.
AVIONICS SYSTEMS ARCHITECTURES
James D. Engelland *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 15-25 (For primary document see N93-27166 10-01)
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07 AIRCRAFT PROPULSION AND POWER

Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and onboard auxilliary power plants for aircraft.

For related information see also *20 Spacecraft Propulsion and Power, 28 Propellants and Fuels,* and *44 Energy Production and Conversion.*

N93-27026*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
EXPERIMENTAL INVESTIGATION OF CROSSFLOW JET MIXING IN A RECTANGULAR DUCT
D. S. Liscinsky (United Technologies Research Center, East Hartford, CT.), B. True (United Technologies Research Center, East Hartford, CT.), and J. D. Holdeman Jun. 1993 10 p Proposed for presentation at the 29th Joint Propulsion Conference and Exhibit, Monterey, CA, 28-30 Jun. 1993; sponsored by AIAA, SAE, ASME, and ASEE Original contains color illustrations
(RTOP 537-02-21)
(NASA-TM-106152; E-7834; NAS 1.15:106152; AIAA Paper 93-2037)
Avail: CASI HC A02/MF A01; 2 functional color pages

An experimental investigation of the mixing of nonreacting opposed rows of jets injected normal to a confined rectangular crossflow has been conducted. Planar Mie-scattering was used to measure the time-average concentration distribution of the jet fluid in planes perpendicular to the duct axis. The mixing effectiveness of round orifice injectors was measured as a function of orifice spacing and orifice diameter. Mixing effectiveness was determined using a spatial unmixedness parameter based on the variance of mean jet concentration distributions. Optimum mixing was obtained when the spacing-to-duct height ratio was inversely proportional to the square root of the jet-to-mainstream momentum-flux ratio. For opposed rows of round holes with centerlines inline, mixing was similar for blockages up to 75 percent. Lower levels of unmixedness were obtained as a function of downstream location when axial injection length was minimized. Mixing may be enhanced if orifice centerlines of opposed rows are staggered, but note that blockage must be less than 50 percent for this configuration.
Author

N93-27115*# United Technologies Research Center, East Hartford, CT.
EXPERIMENTAL INVESTIGATION OF TURBINE DISK CAVITY AERODYNAMICS AND HEAT TRANSFER Final Report
W. A. Daniels and B. V. Johnson May 1993 103 p
(Contract NAS8-37462)
(NASA-CR-193131; NAS 1.26:193131; UTRC-93-957878-27) Avail: CASI HC A06/MF A02

An experimental investigation of turbine disk cavity aerodynamics and heat transfer was conducted to provide an experimental data base that can guide the aerodynamic and thermal design of turbine disks and blade attachments for flow conditions and geometries simulating those of the space shuttle main engine (SSME) turbopump drive turbines. Experiments were conducted to define the nature of the aerodynamics and heat transfer of the flow within the disk cavities and blade attachments of a large scale model simulating the SSME turbopump drive turbines. These experiments include flow between the main gas path and the disk cavities, flow within the disk cavities, and leakage flows through the blade attachments and labyrinth seals. Air was used to simulate the combustion products in the gas path. Air and carbon dioxide were used to simulate the coolants injected at three locations in the disk cavities. Trace amounts of carbon dioxide were used to determine the source of the gas at selected locations on the rotors, the cavity walls, and the interstage seal. The measurements on the rotor and stationary walls in the forward and aft cavities showed that the coolant effectiveness was 90 percent or greater when the coolant flow rate was greater than the local free disk entrainment flow rate and when room temperature air was used as both coolant and gas path fluid.

When a coolant-to-gas-path density ratio of 1.51 was used in the aft cavity, the coolant effectiveness on the rotor was also 90 percent or greater at the aforementioned condition. However, the coolant concentration on the stationary wall was 60 to 80 percent at the aforementioned condition indicating a more rapid mixing of the coolant and flow through the rotor shank passages. This increased mixing rate was attributed to the destabilizing effects of the adverse density gradients. Author

N93-27128*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

CFD MIXING ANALYSIS OF AXIALLY OPPOSED ROWS OF JETS INJECTED INTO CONFINED CROSSFLOW

D. B. Bain (CFD Research Corp., Huntsville, AL.), C. E. Smith (CFD Research Corp., Huntsville, AL.), and J. D. Holdeman May 1993 29 p Prepared for presentation at the 28th Joint Propulsion Conference and Exhibit, Monterey, CA, 28-30 Jun. 1993; sponsored by AIAA, SAE, ASME, and ASEE Original contains color illustrations

(RTOP 537-02-21)

(NASA-TM-106179; E-7884; NAS 1.15:106179; AIAA Paper 93-2044)

Avail: CASI HC A03/MF A01; 12 functional color pages

A computational fluid dynamics (CFD) parametric study was performed to analyze axially opposed rows of jets mixing with crossflow in a rectangular duct. Isothermal analysis was conducted to determine the influence of lateral geometric arrangement on mixing. Two lateral arrangements were analyzed: (1) inline (jets' centerlines aligned with each other on top and bottom walls), and (2) staggered (jets' centerlines offset with each other on top and bottom walls). For a jet-to-mainstream mass flow ratio (MR) of 2.0, design parameters were systematically varied for jet-to-mainstream momentum-flux ratios (J) between 16 and 64 and orifice spacing-to-duct height ratios (S/H) between 0.125 and 1.5. Comparisons were made between geometries optimized for S/H at a specified J. Inline configurations had a unique spacing for best mixing at a specified J. In contrast, staggered configurations had two 'good mixing' spacings for each J, one corresponding to optimum inline spacing and the other corresponding to optimum non-impinging jet spacing. The inline configurations, due to their smaller orifice size at optimum S/H, produced better initial mixing characteristics. At downstream locations (e.g. x/H of 1.5), the optimum non-impinging staggered configuration produced better mixing than the optimum inline configuration for J of 64; the opposite results were observed for J of 16. Increasing J resulted in better mixing characteristics if each configuration was optimized with respect to orifice spacing. Mixing performance was shown to be similar to results from previous dilution jet mixing investigations (MR less than 0.5). Author (revised)

N93-27130*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

VELOCITY AND DROP SIZE MEASUREMENTS IN A SWIRL-STABILIZED, COMBUSTING SPRAY

Daniel L. Bulzan Jan. 1993 12 p Presented at the Laser Applications in Combustion and Combustion Diagnostics Meeting, Los Angeles, CA, 16-23 Jan. 1993; sponsored by Society of Photo-Optical Instrumentation Engineers

(RTOP 505-62-52)

(NASA-TM-106130; E-7799; NAS 1.15:106130) Avail: CASI HC A03/MF A01

Velocity and drop size measurements are reported for a swirl-stabilized, combusting spray. For the gas phase, three components of mean and fluctuating velocity are reported. For the droplets, three components of mean and fluctuating velocity, diameter, and number flux are reported. The liquid fuel utilized for all the tests was heptane. The fuel was injected using an air-assist atomizer. The combustor configuration consisted of a center-mounted, air-assist atomizer surrounded by a coflowing air stream. Both the coflow and the atomizing air streams were passed through 45 degree swirlers. The swirl was imparted to both streams in the same direction. The combustion occurred unconfined in stagnant surroundings. The nonintrusive measurements were obtained using a two-component phase/Doppler particle analyzer. The laser-based instrument measured two components of velocity as well as droplet size at a particular point. Gas phase measurements were obtained by seeding the air streams with nominal 1 micron size aluminum-oxide particles and using the measured velocity from that size to represent the gas phase velocity. The atomizing air, coflow air, and ambient surroundings were all seeded with the aluminum-oxide particles to prevent biasing. Measurements are reported at an axial distance of 5 mm from the nozzle. Isothermal single-phase gas velocities are also reported for comparison with the combusting case. Author

N93-27131*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

PERFORMANCE CHARACTERISTICS OF A VARIABLE-AREA VANE NOZZLE FOR VECTORING AN ASTOVL EXHAUST JET UP TO 45 DEG

Jack G. McArdle and Barbara S. Esker Jun. 1993 34 p Presented at the 29th AIAA Joint Propulsion Conference, Monterey, CA, 28-30 Jun. 1993; sponsored by AIAA, SAE, ASME, and ASEE

(RTOP 505-68-32)

(NASA-TM-106114; E-7768; NAS 1.15:106114; AIAA Paper 93-2437)

Avail: CASI HC A03/MF A01

Many conceptual designs for advanced short-takeoff, vertical landing (ASTOVL) aircraft need exhaust nozzles that can vector the jet to provide forces and moments for controlling the aircraft's movement or attitude in flight near the ground. A type of nozzle that can both vector the jet and vary the jet flow area is called a vane nozzle. Basically, the nozzle consists of parallel, spaced-apart flow passages formed by pairs of vanes (vanesets) that can be rotated on axes perpendicular to the flow. Two important features of this type of nozzle are the abilities to vector the jet rearward up to 45 degrees and to produce less harsh pressure and velocity footprints during vertical landing than does an equivalent single jet. A one-third-scale model of a generic vane nozzle was tested with unheated air at the NASA Lewis Research Center's Powered Lift Facility. The model had three parallel flow passages. Each passage was formed by a vaneset consisting of a long and a short vane. The longer vanes controlled the jet vector angle, and the shorter controlled the flow area. Nozzle performance for three nominal flow areas (basic and plus or minus 21 percent of basic area), each at nominal jet vector angles from -20 deg (forward of vertical) to +45 deg (rearward of vertical) are presented. The tests were made with the nozzle mounted on a model tailpipe with a blind flange on the end to simulate a closed cruise nozzle, at tailpipe-to-ambient pressure ratios from 1.8 to 4.0. Also included are jet wake data, single-vaneset vector performance for long/short and equal-length vane designs, and pumping capability. The pumping capability arises from the subambient pressure developed in the cavities between the vanesets, which could be used to aspirate flow from a source such as the engine compartment. Some of the performance characteristics are compared with characteristics of a single-jet nozzle previously reported. Author (revised)

N93-27160*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

AN ANALYTICAL STUDY OF DILUTION JET MIXING IN A CYLINDRICAL DUCT

V. L. Oechsle (General Motors Corp., Indianapolis, IN.), H. C. Mongia (General Motors Corp., Indianapolis, IN.), and J. D. Holdeman May 1993 41 p Proposed for presentation at the 29th Joint Propulsion Conference and Exhibit, Monterey, CA, 28-30 Jun. 1993; sponsored by AIAA, SAE, ASME, and ASEE LIMITED REPRODUCIBILITY: More than 20% of this document may be affected by color photographs Original contains color illustrations

(RTOP 537-02-21)

(NASA-TM-106181; E-7887; NAS 1.15:106181; AIAA Paper 93-2043)

Copyright Avail: CASI HC A03/MF A01; 17 functional color pages

The mixing performance in a mixing section of a rich burn/quick mix/lean burn (RQL) combustor was calculated using a 3-D numerical model in a non-reacting environment. The numerically calculated results were compared with the measured data reported by Hatch, Sowa, Samuelsen, and Holdeman, 1992. The numerical 3-D temperature fields qualitatively agree with the experimental data. Also, the development of the mixing flow and temperature non-uniformity trends throughout the mixing section for the numerically calculated results quantitatively agree with the measured data. The numerical model predicts less mixing and enhances the temperature gradients as compared to the measured data for the cases reported by Hatch et al. (1992) which include circular and slot orifice shapes (with different slant angles and aspect ratios). The predicted and measured results generally agree in the selection of the slanted slot orifice configuration yielding the best overall mixing performance (based on temperature uniformity) of all the configurations analyzed. Author (revised)

N93-27610*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

COMPARISON OF REACTING AND NON-REACTING SHEAR LAYERS AT A HIGH SUBSONIC MACH NUMBER

C. T. Chang, C. J. Marek, C. Wey (Sverdrup Technology, Inc., Brook Park, OH.), R. A. Jones (Rensselaer Polytechnic Inst., Troy, NY.), and M. J. Smith (Purdue Univ., West Lafayette, IN.) Jun. 1993 13 p Presented at the 29th Joint Propulsion Conference and Exhibit, Monterey, CA, 28-30 Jun. 1993; cosponsored by AIAA, SAE, ASME, and ASEE

(RTOP 505-62-52)

(NASA-TM-106198; E-7905; NAS 1.15:106198; AIAA Paper 93-2381) Avail: CASI HC A03/MF A01

The flow field in a hydrogen-fueled planar reacting shear layer was measured with an LDV system and is compared with a similar air to air case without combustion. Measurements were made with a speed ratio of 0.34 with the highspeed stream at Mach 0.71. They show that the shear layer with reaction grows faster than one without, and both cases are within the range of data scatter presented by the established database. The coupling between the streamwise and the cross-stream turbulence components inside the shear layer is slow, and reaction only increased it slightly. However, a more organized pattern of the Reynolds stress is present in the reacting shear layer, possibly as a result of larger scale structure formation in the layer associated with heat release. Author

N93-27640*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

NDE OF PWA 1480 SINGLE CRYSTAL TURBINE BLADE MATERIAL

Stanley J. Klima, Thomas W. Orange, and Robert L. Dreshfield Apr. 1993 11 p Presented at the SAE Aerospace Atlantic Conference, Dayton, OH, 20-23 Apr. 1993

(RTOP 323-51-60)

(NASA-TM-106140; E-7351; NAS 1.15:106140) Avail: CASI HC A03/MF A01

Cantilever bending fatigue specimens were examined by fluorescent liquid penetrant and radioactive gas penetrant (Krypton) non-destructive evaluation (NDE) methods and tested. Specimens with cast, ground, or polished surface were evaluated to study the effect of surface condition on NDE and fatigue crack initiation. Fractographic and metallurgical analyses were performed to determine the nature of crack precursors. Preliminary results show that fatigue strength was lower for specimens with cast surfaces than for specimens with machined surfaces. The liquid penetrant and gas penetrant techniques both provided indications of a large population of defects on the cast surfaces. On ground or polished specimen surfaces, the gas penetrant appeared to estimate the actual number of voids more accurately than the liquid penetrant. Author (revised)

N93-27679# Wright Lab., Wright-Patterson AFB, OH.

AN ASSESSMENT OF INLET TOTAL-PRESSURE DISTORTION REQUIREMENTS FOR THE COMPRESSOR RESEARCH FACILITY (CFR) Final Report, 1 Aug. 1991 - 31 Aug. 1992

Gregory S. Bloch Aug. 1992 39 p

(AF Proj. 3066)

(AD-A262299; WL-TR-92-2066) Avail: CASI HC A03/MF A01

A study was conducted to determine the potential requirements for inlet total-pressure distortion in the Wright Laboratory Compressor Research Facility (CRF). The study included types and levels of distortion of interest, generation methods, instrumentation, and test techniques. Cost comparisons of various options were generated. Based on this study, it was determined that time-variant distortion testing is beyond the scope of the CRF mission and that screens should continue to be used to generate steady-state distortion. DTIC

N93-27680*# United Technologies Research Center, East Hartford, CT.

EXPERIMENTAL STUDY OF CROSS FLOW MIXING IN CYLINDRICAL AND RECTANGULAR DUCTS Final Report

D. S. Liscinsky, A. Vranos (AB Research Associates, South Windsor, CT.), and R. P. Lohmann (Pratt and Whitney Aircraft, East Hartford, CT.) Apr. 1993 39 p Original contains color illustrations

(Contract NAS3-25952; RTOP 537-02-20)

(NASA-CR-187141; E-7708; NAS 1.26:187141) Avail: CASI HC A03/MF A01; 8 functional color pages

An experimental investigation of non-reacting cross flow jet injection and mixing in cylindrical and rectangular ducts has been conducted with application to a low emissions combustor. Quantitative measurement of injectant concentration distributions perpendicular to the duct axis were obtained by planar digital imaging of the Mie-scattered light from an aerosol seed mixed with the injectant. The flowfield unmixedness was evaluated using (1) a mixing parameter derived from the ratio of the jet concentration fluctuations to the fully mixed concentration, and (2) probability density functions of the concentration distributions. Mixing rate was measured for 45 degree slant slot and round orifice injectors. Author (revised)

N93-28184# Naval Postgraduate School, Monterey, CA.

ESTIMATING CHARACTERISTIC LIFE AND RELIABILITY OF AN AIRCRAFT ENGINE COMPONENT IMPROVEMENT IN THE EARLY STAGES OF THE IMPLEMENTATION PROCESS M.S. Thesis

Scott L. Martens Dec. 1992 84 p

(AD-A262118) Avail: CASI HC A05/MF A01

This thesis describes the database needed to assess improvement in the performance of a modification to the long electroless nickel (LEN) fuel tube of the TF-34-400 engine during the time the modified component is being introduced into the fleet. It also provides the methods and equations for estimating the reliability of a modified component during its implementation. The component failure times are assumed to have a Weibull distribution. When implemented, this methodology will provide engine program management teams more timely information which should enhance their decision-making process significantly. DTIC

N93-28391# McDonnell-Douglas Electronics Co., Saint Louis, MO.

ANALYTICAL AND EXPERIMENTAL INVESTIGATION OF ANNULAR PROPULSIVE NOZZLES Final Report, 9 Jan. 1984 - 9 Jan. 1986

Ralph R. Conley, Joe D. Hoffman, and H. D. Thompson Mar. 1993 37 p

(Contract F33615-81-C-2078)

(AD-A262685; WL-TR-93-2048) Avail: CASI HC A03/MF A01

The final report consists of AIAA papers. The report presents an analytical performance prediction methodology for annular propulsion nozzles with and without swirl introduced in the combustor upstream of the nozzle. Four types of swirlers were investigated: free vortex, constant angle, forced vortex and Rankine vortex swirlers. For the no-swirl case thrust efficiencies and static pressure profiles from cold flow testing of selected nozzles are summarized and compared to the predictions. DTIC

N93-27185 Technion - Israel Inst. of Tech., Haifa. Faculty of Aerospace Engineering.

REGRESSION RATE MECHANISM IN A SOLID FUEL RAMJET

Ilan Hadar and Alon Gany *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 154-162 (For primary document see N93-27166 10-01)

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N93-27186 Technion - Israel Inst. of Tech., Haifa. Faculty of Aerospace Engineering.

DEVELOPMENT OF A PULSE RAMJET BASED ON TWIN VALVELESS PULSE COMBUSTORS COUPLED TO OPERATE IN ANTIPHASE

N. Libis and Y. Goldman *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 163-170 (For primary document see N93-27166 10-01)

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N93-27187 Technion - Israel Inst. of Tech., Haifa. Faculty of Aerospace Engineering.

ANALYSIS OF THRUST MODULATION OF RAM-ROCKETS BY A VORTEX VALVE

Claudio Goldman and Alon Gany *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 171-177 (For primary document see N93-27166 10-01)

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N93-27189 Israel Society of Aeronautics and Astronautics, Tel Aviv.

BY-PASSING OF HEAT EXCHANGERS IN GAS TURBINES

David Lior *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 185-196 (For primary document see N93-27166 10-01)
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08 AIRCRAFT STABILITY AND CONTROL

Includes aircraft handling qualities; piloting; flight controls; and autopilots.

For related information see also *05 Aircraft Design, Testing and Performance.*

N93-26907*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ROBUSTNESS ENHANCEMENT OF NEUROCONTROLLER AND STATE ESTIMATOR
Terry Troudet (Sverdrup Technology, Inc., Brook Park, OH.) Feb. 1993 7 p Proposed for presentation at the World Congress on Neural Networks (WCNN), Portland, OR, 11-15 Jul. 1993; sponsored by International Neural Network Society
(RTOP 505-62-50)
(NASA-TM-106028; E-7590; NAS 1.15:106028) Avail: CASI HC A02/MF A01

The feasibility of enhancing neurocontrol robustness, through training of the neurocontroller and state estimator in the presence of system uncertainties, is investigated on the example of a multivariable aircraft control problem. The performance and robustness of the newly trained neurocontroller are compared to those for an existing neurocontrol design scheme. The newly designed dynamic neurocontroller exhibits a better trade-off between phase and gain stability margins, and it is significantly more robust to degradations of the plant dynamics. Author

N93-27156*# California Polytechnic State Univ., San Luis Obispo. Dept. of Aeronautical Engineering.
LOW BANDWIDTH ROBUST CONTROLLERS FOR FLIGHT Final Report, Jun. 1991 - Dec. 1992
Daniel J. Biezad and Hwei-Lan Chou May 1993 96 p
(Contract NCC2-711)
(NASA-CR-193085; NAS 1.26:193085) Avail: CASI HC A05/MF A01

Through throttle manipulations, engine thrust can be used for emergency flight control for multi-engine aircraft. Previous study by NASA Dryden has shown the use of throttles for emergency flight control to be very difficult. In general, manual fly-by-throttle is extremely difficult - with landing almost impossible, but control augmentation makes runway landings feasible. Flight path control using throttles-only to achieve safe emergency landing for a large jet transport airplane, Boeing 720, was investigated using Quantitative Feedback Theory (QFT). Results were compared to an augmented control developed in a previous simulation study. The control augmentation corrected the unsatisfactory open-loop characteristics by increasing system bandwidth and damping, but increasing the control bandwidth substantially proved very difficult. The augmented pitch control is robust under no or moderate turbulence. The augmented roll control is sensitive to configuration changes. Author

N93-27264*# Joint Inst. for Advancement of Flight Sciences, Hampton, VA.
PRACTICAL INPUT OPTIMIZATION FOR AIRCRAFT PARAMETER ESTIMATION EXPERIMENTS Ph.D. Thesis, 1990
Eugene A. Morelli May 1993 175 p
(Contract NCC1-29; RTOP 505-64-52-01)
(NASA-CR-191462; NAS 1.26:191462) Avail: CASI HC A08/MF A02

The object of this research was to develop an algorithm for the design of practical, optimal flight test inputs for aircraft parameter estimation experiments. A general, single pass technique was developed which allows global optimization of the flight test input design for parameter estimation using the principles of dynamic programming with the input forms limited to square waves only. Provision was made for practical constraints on the input, including amplitude constraints, control system dynamics, and selected input frequency range exclusions. In addition, the input design was accomplished while imposing output amplitude constraints required by model validity and considerations of safety during the flight test. The algorithm has multiple input design capability, with optional inclusion of a constraint that only one control move at a time, so that a human pilot can implement the inputs. It is shown that the technique can be used to design experiments for estimation of open loop model parameters from closed loop flight test data. The report includes a new formulation of the optimal input design problem, a description of a new approach to the solution, and a summary of the characteristics of the algorithm, followed by three example applications of the new technique which demonstrate the quality and expanded capabilities of the input designs produced by the new technique. In all cases, the new input design approach showed significant improvement over previous input design methods in terms of achievable parameter accuracies. Author (revised)

N93-27308*# Kansas Univ., Lawrence.
DESIGN, ANALYSIS, AND CONTROL OF LARGE TRANSPORT AIRCRAFT UTILIZING ENGINE THRUST AS A BACKUP SYSTEM FOR THE PRIMARY FLIGHT CONTROLS
Donna S. Gerren Feb. 1993 120 p
(Grant NAG2-789)
(NASA-CR-192938; NAS 1.26:192938) Avail: CASI HC A06/MF A02

A review of accidents that involved the loss of hydraulic flight control systems serves as an introduction to this project. In each of the accidents--involving transport aircraft such as the DC-10, the C-5A, the L-1011, and the Boeing 747--the flight crew attempted to control the aircraft by means of thrust control. Although these incidents had tragic endings, in the absence of control power due to primary control system failure, control power generated by selective application of engine thrust has proven to be a viable alternative. NASA Dryden has demonstrated the feasibility of controlling an aircraft during level flight, approach, and landing conditions using an augmented throttles-only control system. This system has been successfully flown in the flight test simulator for the B-720 passenger transport and the F-15 air superiority fighter and in actual flight tests for the F-15 aircraft. The Douglas Aircraft Company is developing a similar system for the MD-11 aircraft. The project's ultimate goal is to provide data for the development of thrust control systems for mega-transports (600+ passengers). Author (revised)

N93-27546# Naval Postgraduate School, Monterey, CA.
THE DESIGN OF A ROBUST AUTOPILOT FOR THE ARCHYTAS PROTOTYPE VIA LINEAR QUADRATIC SYNTHESIS M.S. Thesis
Joseph P. Davis Dec. 1992 131 p
(AD-A262151) Avail: CASI HC A07/MF A02

The purpose of this research is to design, simulate, and implement a robust autopilot for the vertical mode of operation of the Archytas prototype. Archytas is an Unmanned Air Vehicle that is designed to take off and land vertically, and to transition to horizontal forward flight. A feedback control scheme is designed for both the single-input, single-output and the multi-input, multi-output subsystems using optimal control techniques. In this research, the linear quadratic regulator performance measure is modified to allow for its application to the tracking problem solution. Additionally, the control systems are designed using reduced order models. Computer simulations show that the reduced order controller designs provide results comparable to the full order controller designs. Successful hardware tests with the roll rate control system validated the reduced order model design philosophy used in this research. DTIC

N93-27603*# Lockheed Engineering and Sciences Co., Hampton, VA.
KNOWLEDGE-BASED REASONING IN THE PALADIN TACTICAL DECISION GENERATION SYSTEM Final Report
Alan R. Chappell Washington May 1993 10 p
(Contract NAS1-19000; RTOP 505-64-30-01)
(NASA-CR-4507; NAS 1.26:4507) Avail: CASI HC A02/MF A01

A real-time tactical decision generation system for air combat engagements, Paladin, has been developed. A pilot's job in air combat includes tasks that are largely symbolic. These symbolic tasks are generally performed through the application of experience and training (i.e. knowledge) gathered over years of flying a fighter aircraft. Two such tasks, situation assessment and throttle control, are identified and broken out in Paladin to be handled by specialized knowledge based systems. Knowledge pertaining to these tasks is encoded into rule-bases to provide the foundation for decisions. Paladin uses a custom built inference engine and a partitioned

rule-base structure to give these symbolic results in real-time. This paper provides an overview of knowledge-based reasoning systems as a subset of rule-based systems. The knowledge used by Paladin in generating results as well as the system design for real-time execution is discussed. Author

N93-27171 California Univ., Los Angeles. Dept. of Mechanical, Aerospace and Nuclear Engineering.
GAME THEORETIC SYNTHESIS FOR ROBUST AEROSPACE CONTROLLERS
Jason L. Speyer *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 31-41 (For primary document see N93-27166 10-01)
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N93-27208 Tel-Aviv Univ. (Israel). Faculty of Engineering.
THE EFFECT OF A FINITE ROLL RATE ON THE MISS-DISTANCE OF A BANK-TO-TURN MISSILE
T. Miloh, M. Pachter (Wright Research Development Center, Wright-Patterson AFB, OH.), and A. Segal (Israel Aircraft Industries Ltd., Lod.) *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 355-362 (For primary document see N93-27166 10-01)
Copyright Avail: Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel

N93-27450*# United Technologies Research Center, East Hartford, CT.
UNSTEADY TRANSITION MEASUREMENTS ON A PITCHING THREE-DIMENSIONAL WING
Peter F. Lorber and Franklin O. Carta *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 14 p (For primary document see N93-27427 10-02)
(Contract DAAL03-89-C-0013)
Avail: CASI HC A03/MF A04

09 RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tubes; and aircraft engine test stands.

For related information see also *14 Ground Support Systems and Facilities (Space).*

N93-26636# Transportation Research Board, Washington, DC.
AIRPORT LANDSIDE PLANNING AND OPERATIONS Transportation Research Record
1992 50 p
(PB93-167880; TRB/TRR-1373) Avail: CASI HC A03/MF A01

This document contains the following: Toronto Island airport access; dynamic capacity of airport enplaning curbside areas; evolution of ground transportation management as a major airport function; public transportation for airport employees: the Q3 extension into John F. Kennedy International Airport; and planning of parallel pier airport terminals with automated people mover systems under constrained conditions. NTIS

N93-27142*# George Washington Univ., Washington, DC. School of Engineering and Applied Science.
ANALYSIS OF FLUCTUATING STATIC PRESSURE MEASUREMENTS IN A LARGE HIGH REYNOLDS NUMBER TRANSONIC CRYOGENIC WIND TUNNEL Ph.D. Thesis
William B. Igoe 1991 258 p Sponsored by NASA. Langley Research Center
(NASA-TM-108722; NAS 1.15:108722) Avail: CASI HC A12/MF A03

Dynamic measurements of fluctuating static pressure levels were made using flush mounted high frequency response pressure transducers at eleven locations in the circuit of the National Transonic Facility (NTF) over the complete operating range of this wind tunnel. Measurements were made at test section Mach numbers from 0.2 to 1.2, at pressure from 1 to 8.6 atmospheres and at temperatures from ambient to -250 F, resulting in dynamic flow disturbance measurements at the highest Reynolds numbers available in a transonic ground test facility. Tests were also made independently at variable Mach number, variable Reynolds number, and variable drivepower, each time keeping the other two variables constant thus allowing for the first time, a distinct separation of these three important variables. A description of the NTF emphasizing its flow quality features, details on the calibration of the instrumentation, results of measurements with the test section slots covered, downstream choke, effects of liquid nitrogen injection and gaseous nitrogen venting, comparisons between air and nitrogen, isolation of the effects of Mach number, Reynolds number, and fan drive power, and identification of the sources of significant flow disturbances is included. The results indicate that primary sources of flow disturbance in the NTF may be edge-tones generated by test section sidewall re-entry flaps and the venting of nitrogen gas from the return leg of the tunnel circuit between turns 3 and 4 in the cryogenic mode of operation. The tests to isolate the effects of Mach number, Reynolds number, and drive power indicate that Mach number effects predominate. A comparison with other transonic wind tunnels shows that the NTF has low levels of test section fluctuating static pressure especially in the high subsonic Mach number range from 0.7 to 0.9. Author (revised)

N93-28189# Naval Postgraduate School, Monterey, CA.
MODIFICATION AND CALIBRATION OF THE NAVAL POSTGRADUATE SCHOOL ACADEMIC WIND TUNNEL M.S. Thesis
Robert L. Baldocchi 17 Dec. 1992 83 p
(AD-A262092) Avail: CASI HC A05/MF A01

Since the early 1980's, the Academic Wind Tunnel has operated with only one half its designed power section. Resultant flow qualities have limited the use of this facility. A damping screen was installed in the settling chamber to reduce the level of turbulence intensity in the tunnel. Following this modification, calibration measurements in the vertical centerplane were performed to document flow conditions in the test section. The tunnel calibration investigated lateral pressure variations, flow angularity, and turbulence intensity and included an airspeed calibration. When available results were compared to data from calibrations performed before the tunnel modification. Results indicate the total and static pressure lateral variation is within 1.0% angular variation of approximately +/-1.0 deg exists in the test section, and a 25.0% reduction in turbulence intensity was obtained due to the presence of the damping screen. Flow separation in the diffuser is believed to be influencing total pressure oscillation in the test section. DTIC

12 ASTRONAUTICS (GENERAL)

For extraterrestrial exploration see *91 Lunar and Planetary Exploration.*

N93-26948*# Alabama Univ., Huntsville. Center for Microgravity and Materials Research.
ACCELERATION STUDIES Final Report, 19 Mar. 1992 - 18 Apr. 1993
Melissa J. B. Rogers 18 Apr. 1993 62 p
(Contract NAS8-38609)
(NASA-CR-192547; NAS 1.26:192547) Avail: CASI HC A04/MF A01

Work to support the NASA MSFC Acceleration Characterization and Analysis Project (ACAP) was performed. Four tasks (analysis development, analysis research, analysis documentation, and acceleration analysis) were addressed by parallel projects. Work concentrated on preparation for and implementation of near real-time SAMS data analysis during the USMP-1 mission. User support documents and case specific software documentation and tutorials were developed. Information and results were presented to microgravity users. ACAP computer facilities need to be fully implemented and networked, data resources must be cataloged and accessible, future microgravity missions must be coordinated, and continued Orbiter characterization is necessary. For individual titles, see N93-26949 through N93-26950.

N93-26949*# Alabama Univ., Huntsville.
DADiSP PROCESSING GUIDE **c61**
Melissa J. B. Rogers *In its* Acceleration Studies 18 Apr. 1993 23 p
(For primary document see N93-26948 10-12)
Avail: CASI HC A03/MF A01

A guide for DADiSP software, intended for use by the Lambda Point Experiment (LPE) Team during and after the United States Microgravity Payload (USMP)-1 mission, is presented. DADiSP is a Data Analysis and

Display Software developed and marketed by DSP Development Corporation, Cambridge, Massachusetts. This guide is intended to be used in addition to the DADiSP Worksheet User Manual and Reference Manual which are supplied by the company with the software. Technical support for DADiSP is available from DSP at (617) 577-1133. Access to DADiSP on Acceleration Characterization and Analysis Project (ACAP) EGSE is being provided to the LPE team during USMP-1 for off-line processing of SAMS data.
Author (revised)

N93-26950*# Alabama Univ., Huntsville. Center for Microgravity and Materials Research.
A COMPARISON OF LOW-GRAVITY MEASUREMENTS ON-BOARD COLUMBIA DURING STS-40 **c29**
Melissa J. B. Rogers, C. R. Baugher, R. C. Blanchard (National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.), R. DeLombard (National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.), W. W. Durgin (Worcester Polytechnic Inst., MA.), D. H. Matthiesen (Case Western Reserve Univ., Cleveland, OH.), W. Neupert (National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.), and P. Roussel (European Space Research Lab., Noordwijk, Netherlands.) *In its* Acceleration Studies 18 Apr. 1993 20 p (For primary document see N93-26948 10-12)
Avail: CASI HC A03/MF A01

The first NASA Spacelab Life Sciences mission (SLS-1) flew 5 Jun. to 14 Jun. 1991 on the orbiter Columbia (STS-40). The purpose of the mission was to investigate the human body's adaptation to the low-gravity conditions of space flight and the body's readjustment after the mission to the 1 g environment of earth. In addition to the life sciences experiments manifested for the Spacelab module, a variety of experiments in other scientific disciplines flew in the Spacelab and in Get Away Special (GAS) Canisters on the GAS Bridge Assembly. Several principal investigators designed and flew specialized accelerometer systems to better assess the results of their experiments by means of a low-gravity environment characterization. This was also the first flight of the NASA Microgravity Science and Applications Division (MSAD) sponsored Space Acceleration Measurement System (SAMS) and the first flight of the NASA Orbiter Experiments Office (OEX) sponsored Orbital Acceleration Research Experiment accelerometer (OARE). A brief introduction to seven STS-40 accelerometer systems are presented and the resulting data are discussed and compared. During crew sleep periods, acceleration magnitudes in the 10(exp -6) to 10(exp -5) g range were recorded in the Spacelab module and on the GAS Bridge Assembly. Magnitudes increased to the 10(exp -4) g level during periods of nominal crew activity. Vernier thruster firings caused acceleration shifts on the order of 10(exp -4) g and primary thruster firings caused accelerations as great as 10(exp -2) g. Frequency domain analysis revealed typical excitation of Orbiter and Spacelab structural modes at 3.5, 4.7, 5.2, 6.2, 7, and 17 Hz. Author (revised)

N93-27286# Joint Publications Research Service, Arlington, VA.
JPRS REPORT: SCIENCE AND TECHNOLOGY. CENTRAL EURASIA: SPACE
18 May 1993 62 p Transl. into ENGLISH from various Russian articles (JPRS-USP-93-002) Avail: CASI HC A04/MF A01

Translations are presented covering the following topics: manned mission highlights; space sciences; interplanetary sciences; space engineering; space applications; and space policy, administration. CASI

N93-27290*# National Aeronautics and Space Administration, Washington, DC.
NASA DISCOVERY PROGRAM WORKSHOP Summary Report
1992 64 p Workshop held in San Juan Capistrano, CA, 16-20 Nov. 1992
(NASA-TM-108233; NAS 1.15:108233) Avail: CASI HC A04/MF A01

The purpose of the workshop was to review concepts for Discover-class missions that would follow the first two missions (MESUR-Pathfinder and NEAR) of this new program. The concepts had been generated by scientists involved in NASA's Solar System Exploration Program to carry out scientifically important investigations within strict guidelines -- $150 million cap on development cost and 3 year cap on development schedule. Like the Astrophysics Small Explorers (SMEX), such 'faster and cheaper' missions could provide vitality to solar system exploration research by returning high quality data more frequently and regularly and by involving many more young researchers than normally participate directly in larger missions. An announcement of opportunity (AO) to propose a Discovery mission to NASA is expected to be released in about two years time. One purpose of the workshop was to assist Code SL in deciding how to allocate its advanced programs resources. A second, complimentary purpose was to provide the concept proposers with feedback to allow them to better prepare for the AO. Derived from text

N93-28014# National Space Development Agency, Ibaraki (Japan).
FUTURE SPACE ACTIVITY WORKSHOP: LUNAR BASE WORKSHOP 1992 [SHOURAI NO UCHUU KATSUDOU WAKUSHOPPU: GETSUMEN KICHI WAKUSHAPPU 1992]
15 Jul. 1992 653 p In ENGLISH and JAPANESE Workshop held in Ibaraki, Japan, 15-17 Jul. 1992
(JTN-93-80420) Avail: CASI HC A99/MF A06

The following topics were discussed: Japanese space program, Japanese spacecraft, lunar site, lunar exploration, Mars exploration, lunar roving vehicles, manned engineering test satellites, artificial gravity, life support system, solar power satellites, satellite microminiaturization, hazardous material disposal, propellant storage in orbit, reusable launch vehicle, fly-back booster, space transportation system, spaceborne experiment, mars probes, lunar probes, lunar resources, resource exploration, lunar landing module, mars exploration, satellite orbits, earth-Mars trajectories, Rosetta mission, and Galileo satellite. For individual titles, see N93-28015 through N93-28049.

N93-28015# National Space Development Agency, Ibaraki (Japan). Launch Vehicle and Satellite System Lab.
FUTURE SPACE ACTIVITIES: HOW CAN A BABY HAVING GROWN UP TOO MUCH IN A CRADLE BE DEALT WITH? [SHOURAI NO UCHUU KATSUDOU: YURIKAGO IPPAI NIMADE SODATTE SHIMATTA AKANBOU WA DOUSUREBA YOINOKA]
Tsutomu Iwata *In its* Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 6 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A02/MF A06

A problem is posed on the future of space activities. Human production activities, which have incessantly continued since the dawn of history, have reached a level at which irreversible damage to the earth environment has occurred. By human production activities we mean to extract specific substance, i.e., petroleum, from the earth, let it undergo chemical or physical change, and then return it to the earth environment. The problem is that rapid growth of mechanical production capability since the Industrial Revolution has resulted in an exhaustion of raw materials and detrimental effects to the earth environment by its products or wastes. The difficulty of conducting large-scale development on the earth without disturbing its environment is evident, and a possible solution to this problem is to generate production infrastructures and proliferate them in space. The self-proliferation capability of infrastructure can be obtained by picking up natural resources and nuclear fuels, utilizing solar energy, dissipating waste heat to the dark space, and building up production equipment systems of considerable scale which actively utilize the microgravity and high vacuum in space. Human beings will keep trying to solve problems of the earth environment, resources, and population on a trial and error basis, and space exploration is seen to be the most natural and traditional solution compatible with the earth environment. Author (NASDA)

N93-28016# Mitsubishi Electric Corp., Kamakura (Japan). Kamakura Works.
MANNED ENGINEERING TEST SATELLITES [YUUJIN GIJUTSU SHIKEN EISEI] **c18**
Hiromi Seko, Masao Satou, Hisao Tomoeda, Hiroaki Obara, and Katsutoshi Oomura *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 22 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

An overview of the conceptual design of manned engineering satellites is presented. The mission scenarios for developing manned engineering satellites involve: (1) selecting mission equipment to enable preferential development and validation of mandatory technologies among those for Environmental Control and Life Support System (ECLSS); (2) selecting mission equipment to enable development and validation of independent

domestic technologies as well as utilizing to the utmost the manned space technology acquired through the Japanese Experimental Module (JEM); and (3) installing the most effective mission on the basis of relationships with Extravehicular Activity (EVA), robot, and retrieval-type spacecraft technologies, and trends of overseas manned space technology. The results of reviews on the system and subsystems, such as attitude and orbit control, structure, thermal control, electric power, communication, and data processing subsystems are outlined. The results of reviews on the structure, weight, and reentry phase operation are presented. Author (NASDA)

N93-28017# Nippon Electric Co. Ltd., Tokyo (Japan).
CONCEPTUAL STUDY ON MANNED ENGINEERING TEST SATELLITES [YUUJIN GIJITSU SHIKEN EISEI NO GAINEN KENTOU] **c18**
Tsuyoshi Okazaki, Tooru Nakano (Nippon Electric Co. Ltd., Tokyo, Japan.), Masabumi Inomata (Nippon Electric Co. Ltd., Tokyo, Japan.), Jun Inagaki (Nippon Electric Co. Ltd., Tokyo, Japan.), and Shigeru Oono (Nippon Electric Co. Ltd., Tokyo, Japan.) *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 21 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

An overview of the conceptual study of spacecraft used for validating technologies which will be necessary for manned space development conducted by Japan in the future is presented. An Environmental Control and Life Support System (ECLSS) and two-phase liquid loop radiator experiment equipment were selected as the major and optional equipment to be installed onboard the manned engineering test satellites, respectively. Mission items for ECLSS experiment equipment were extracted and traded off from the following on-ground technologies: (1) technology for removing toxic substances, offensive substances, and fine particles from the atmosphere; (2) N2 and O2 partial pressure control and CO2 removal technologies; (3) gas sensing technology; and (4) temperature and humidity control technology. Comparison was conducted on three base-line configurations such as follows: (1) pressurized module (expendable) plus bus section (expendable); (2) pressurized module (retrievable) plus bus section (expendable); and (3) pressurized module (expendable) plus bus section (expendable) plus recovery section. The results of the review on the satellite system base on configuration of the above case (1) are outlined. Author (NASDA)

N93-28018# Nissan Motor Co. Ltd., Tokyo (Japan).
ARTIFICIAL GRAVITY EXPERIMENT SATELLITES [JINKOU JUURYOKU JIKKEN EISEI] **c18**
Tadashi Harada *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 21 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

An overview of the conceptual study of an artificial gravity experiment satellite based on the assumption of a launch by the H-2 launch vehicle with a target launch date in the Year 2000 is presented. While many satellites provided with artificial gravity have been reported in relation to a manned Mars exploration spacecraft mission, the review has been conducted on missions and test subjects only for experimental purposes. Mission requirements were determined based on the results of reviews on the mission, test subjects, and model missions. The system baseline and development plan were based on the results of a study on conceptual structure and scale of the system, including measures to generate artificial gravity. Approximate scale of the system and arm length, mission orbit, visibility of the operation orbit from ground stations in Japan, and satellite attitude on the mission orbit are outlined. Author (NASDA)

N93-28019# Fujitsu Ltd., Tokyo (Japan).
LINEARLY CONNECTED SOLAR POWER SATELLITE [CHOKUSEN RENKETSUGATA TAIYOU HATSUDEN EISEI] **c18**
Tetsuji Narasaki and Yoshikazu Doui *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 14 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

A study of the system function of Solar Power Satellite (SPS) was conducted considering related technical problems, such as power transmission (loss, heat, failure, and weight) by slip rings between the platform and rotating antenna, location of antenna installation (method of SPS connection), inertial moment of the antenna, DC (Direct Current)-RF (Radio Frequency) amplifier cooling, and maintenance and checkout (configuration). An example of the system, the SPS unit connection mechanisms, and three types of SPS unit are shown. An overview of the results of study on the efficiency of solar cells, microwave damping in the atmosphere, Solid State Power Amplifier (SSPA), waveguide, and reflector is presented. Major characteristics of the SPS unit are shown. Author (NASDA)

N93-28020# Mitsubishi Electric Corp., Tokyo (Japan).
STUDY OF SATELLITE MICROMINIATURIZATION TECHNOLOGY [EISEI CHOUKOGATAKA GIJUTSU NO KENTOU] **c18**
Hiroaki Obara and Katsutoshi Oomura *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 10 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A02/MF A06

The characteristics, objectives, and missions, such as those for message relaying, low orbit broadcasting, monitoring and warning, scientific observation and space environment monitoring, planet exploration, and technology development of microminiature satellites are outlined. An overview of the study of satellite microminiaturization technologies for communication, information processing, sensing for navigation and observation missions, power supply, actuators, structure and thermal control, and overall system is presented. Author (NASDA)

N93-28021# Nippon Electric Co. Ltd., Tokyo (Japan). Aerospace Systems, Ltd.
STUDY OF SATELLITE MICROMINIATURIZATION TECHNOLOGY [EISEI CHOUKOGATAKA GIJUTSU NO KENTOU] **c18**
Akihiko Kimura, Yukio Matsufuji, and Osamu Nakagawa *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 19 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

Advantage of and problems in microminiaturizing the existing satellites, and new missions for which microminiaturization is employed, such as multi-satellite communication system for global communication, emergency medication communication, and rescue and search, and data storage and transmission satellite system, are outlined. An overview of the study of system structure suitable for microminiature satellites, including their features and standardization, system structure with interface bus system as its center, and the system operation and the microminiaturization element technologies (including those for components, assembly, electric power subsystems, sensors, structures, and methodization), is presented. Ideas about design and control suitable for microminiature satellites and an example of satellite system model (for space experiment satellite) are presented. Author (NASDA)

N93-28022# Hitachi Ltd., Tokyo (Japan).
STUDY OF MINIATURE AND MICROMINIATURE SATELLITE TECHNOLOGY [KOGATA/CHOUKOGATA EISEI GIJUTSU NO KENTOU] **c18**
Kazuhisa Kaneko *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 18 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

An overview of the study on miniaturized satellite missions for the purpose of communication, broadcasting, earth observation, space environment utilization, global positioning, lunar exploration, solar-terrestrial science observation, and astronomical observation is presented. The results from examination of documents and periodicals of technologies expected to be usable for satellite miniaturization is outlined by subsystem, such as orbit and attitude control, electric power, communication, thermal control, and other subsystems. Technical measures for upgrading heat radiation and solar battery efficiencies, and antenna gain are proposed. The results of the study of super-miniature satellite system model (low orbit data relay satellite system for earth observation satellite to process many data) are outlined. Author (NASDA)

N93-28023# Toshiba Corp., Tokyo (Japan).
DEBRIS OBSERVATION AND ARRESTING EXPERIMENT SATELLITE [DEBURI KANSOKU/HOKAKU JIKKEN EISEI] **c18**
Toshinori Yukawa *In* NASDA, Future Space Activity Workshop: Lunar

Base Workshop 1992 15 Jul. 1992 23 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

An overview of the present status and condition of, and future of the observation of debris in space is presented. The results of a survey on documents concerning debris disposal methods are outlined. Missions of debris observation and arresting satellites, such as debris disposal on the space station orbit, anti-debris measures for debris on geostationary orbit, debris disposal at an altitude of less than 1,500 km, and number of spacecraft necessary for debris disposal are introduced. Five conceptual plans for experimental debris observation and arresting satellites are presented. Author (NASDA)

N93-28024# Ishikawajima-Harima Heavy Industries Co. Ltd., Tokyo (Japan).
CONCEPTUAL STUDY OF DEBRIS OBSERVATION AND ARRESTING EXPERIMENT SATELLITE [DEBURI KANSOKU/HOKAKU JIKKEN EISEI NO GAINEN KENTOU] **c18**
Kenichi Kimoto, Hatsuo Mori, Keiichi Satou, Yukihito Kitazawa, and Kouichi Miyoshi *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 22 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

Present status of debris environment and predictable damage caused by them, such as effects to manned space activities, damage of satellite or other spacecraft caused by their collision, dropping of substances to the ground, radioactive contamination, effects to astronomical observation, and interference with space experiments are outlined. An overview of present status and problems of debris observation and tracking system and an ideal debris observation system is presented. The objectives of a debris observation and arresting system and definition of their subjects are introduced. The results of studies of observation equipment (sensors), including contacting and non-contacting sensors, and their selection is introduced. Orbits, mission duration, operational condition, and overall satellite systems are outlined. Author (NASDA)

N93-28025# Hitachi Ltd., Tokyo (Japan). Hitachi Works.
CONCEPTUAL STUDY OF PROPELLANT STORAGE AND TRANSFER ENGINEERING TEST SATELLITE [SUISHINZAI CHOZOU/ISOU GIJUTSU SHIKEN EISEI NO GAINEN KENTOU] **c18**
Yuusuke Ueda, Ryuusuke Abe, Tsunehiko Takakusaki, and Kazutake Imajin *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 17 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

Fundamental structure of propellant storage station flight model was determined based on the studies of operation scenarios, storage methods, transfer methods, and merits and demerits of the various station orbit altitudes in comparison with that of the station. Technical problems concerning cryogenic propellant storage and transfer were picked up along presumable sequence of events from the viewpoints of problematic feasibility, necessity of design data, and durability. The subjects of the engineering test mission selected by the above study were as follows: (1) verification of automatic connection and self sealing capabilities; (2) validation of Thermodynamic Vent System (TVS) in microgravity; and (3) liquid volume (mass) measurement in microgravity. An overview of test equipment to meet the above subjects, the system structure and configuration, and operation plan for the engineering test satellite is presented.
Author (NASDA)

N93-28026# Kawasaki Heavy Industries Ltd., Kobe (Japan).
CONCEPTUAL STUDY OF FLY-BACK BOOSTER [FURAI BAKKU BUSUTA NO GAINEN KENTOU] **c18**
Hikaru Tomita and Kouichi Yonemoto *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 19 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

A conceptual study of a system capable of injecting a 30-ton payload into low orbit with a combination winged and reusable booster and an expendable upper-stage rocket was conducted. The study was conducted in condition that all systems be newly developed and rocket engine propellant be the combination of liquid oxygen and liquid hydrogen or liquid oxygen and liquid methane. A study was conducted to make the scale setting procedures of upper and lower stages clear, using the lower stage structural efficiency as the main parameter. In the above process, optimum delta V distribution was first determined and it was made clear that to distribute more delta V to stages of better structural efficiency is the best. The dimension of the fly-back booster fuselage was determined geometrically from propellant weight and density, and the main wing area had to be determined by repetitive trial and error calculations with the weight allocated to the lower stage and applying weight estimation equations. The appropriateness of the wing area was evaluated by the wing loading at landing. From the results of flight profile computation, it was found that the craft fueled with liquid hydrogen has a probability to return near Tanegasima, while that fueled with liquid methane would return near Ogasawara. Author (NASDA)

N93-28027# Nissan Motor Co. Ltd., Tokyo (Japan).
FLY-BACK BOOSTER [FURAI BAKKU BUSUTA] **c18**
Takashi Makino *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 16 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

An overview of the results of a quantitative evaluation with staging condition as parameters was conducted on a system composed of a fly-back booster model (methane engine plus jet engine equipped for return) and a elongated H-2 launch vehicle first-stage is presented as follows: (1) payload capacity of the model system is 28 tons (200 km low earth orbit); (2) 100 atm (ranging from 50 to 100 atm) is optimum for gas to gas methane engine combustion pressure; (3) the engine aperture ratio is 20; (4) re-entry aerodynamic heating rate is sufficiently within carbon to carbon composite material heat-resistance; and (5) maximum dynamic pressure is 10 kPa and maximum acceleration is 7G at re-entry. The overall system performance of a launch system with fly-back booster can be optimized by repetitively conducting the following procedures: (1) delta V distribution; (2) weight estimate; (3) aerodynamic characteristics estimate; (4) propulsion performance estimate; and (5) orbit analysis. Author (NASDA)

N93-28028# Mitsubishi Heavy Industries Ltd., Nagoya (Japan). Nagoya Aerospace Systems Works.
CONCEPTUAL STUDY OF FLY-BACK BOOSTER [FURAI BAKKU BUSUTA NO GAINEN KENTOU] **c18**
Ryuuichi Minami *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 14 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

Initial sizing of fly-back boosters was conducted on the assumption that the booster returns to the launch site, and the following guidelines concerning configuration selection were obtained: (1) when the booster return is a prerequisite, speed increment allocation to the booster is targeted at less than 3,000 m/sec; (2) to reduce the overall rocket size, increasing the upper-stage structural efficiency is more effective than improving the booster structural efficiency in fly-back booster design; and (3) as the result of comparing four systems for return, a system to re-ignite the booster just after separating the upper-stage and return by ballistic flight is deemed to be most prosperous. After studying two types of systems, winged type returning by ballistic flight and flare type (non-winged), both types are feasible by the existing design and materials. Author (NASDA)

N93-28029# National Space Development Agency, Tokyo (Japan).
CONCEPTUAL STUDY ON MANNED LUNAR SURFACE SITE [YUUJIN GETSUMEN KYOTEN NO GAINEN KENTOU] **c54**
Yutaka Takano *In its* Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 17 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

An overview of the conceptual study of a manned lunar surface site, a small scale activity site for a small number of crew members is presented. The objectives of the manned lunar surface site are as follows: (1) validating that human beings can conduct multiple activities on the lunar surface; (2) validating the feasibility of outstanding development of scientific experiment and technology by human activities on the lunar surface; (3) validating the feasibility of providing materials for space activity and further developing production activities in space; (4) greatly promoting scientific knowledge

about astronomy and space science by astronomical and space science observation on the lunar surface; and (5) allowing a wide range of people to understand the prospects of space development. The design concept and missions of the manned lunar base are outlined. The system and its subsystems, such as structure and mechanism, habitation, electric power, thermal control, communication, control, logistics, flight and landing subsystems are outlined. The construction and operation plans are presented. Author (NASDA)

N93-28030# Mitsubishi Heavy Industries Ltd., Tokyo (Japan).
CONCEPTUAL STUDY OF MANNED LUNAR TRANSPORTATION SYSTEM [YUUJIN TSUKI YUSOU SHISUTEMU NO KOUSOU KENTOU] **c16**

Takahiro Itou *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 15 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

Comparison and conceptual studies were conducted for a manned lunar transportation system with a mission to transport personnel and material to the lunar surface in a manned lunar base phase. The following topics are concluded: (1) a study is required for the purpose of making a relative comparison of gross weight for three systems and a system to minimize the gross weight; (2) function allocations to subsystems based on the study of mission profile etc. and major characteristics, such as weight; and (3) necessary revision of the system when used for freight transportation and the transportation capability. Author (NASDA)

N93-28031# Nippon Electric Co. Ltd., Tokyo (Japan).
CONCEPTUAL STUDY OF MANNED LUNAR SURFACE SITE [YUUJIN GETSUMEN KYOTEN NO GAINEN KENTOU] **c54**

Toshiaki Okudaira, Haruki Ayata, Kiyoshi Tanaka, Nobutaka Katou, and Naoki Yoshizawa *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 22 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

An overview of a study of a lunar surface site system which does not necessitate Extravehicular Activity (EVA) and robotic support in starting the site is presented. Functional and performance requirements for the system, system configurations, system structure, weight and electric power allotments, and subsystems (such as structures, habitat, electric power, thermal control, communication control experiment, logistics, and flight and landing subsystems) were studied. Interface requirements with other systems, such as ground test equipment, launch vehicle, earth orbit assembly facility, ground control station, manned lunar landing and take-off vehicle, and lunar freight transport vehicle were also studied. Construction methods, such as operations robots, construction procedures, and leveling mechanism after landing are outlined. The results of the study of operation and maintenance methods and system analysis are introduced. The functional requirements, system concept, operation methods, including remote control, automation, automation, and development and operation plan for robots are outlined. Author (NASDA)

N93-28032# Ishikawajima-Harima Heavy Industries Co. Ltd., Tokyo (Japan).
MANNED LUNAR SURFACE SITE: CONCEPTUAL STUDY ON PRESSURIZED LUNAR SURFACE OPERATION ROVER [YUUJIN GETSUMEN KYOTEN: YOATSUGATA GETSUMEN SAGYOU ROBA NO GAINEN KENTOU] **c54**

Youichirou Nakamura, Keiko Yasuda, Isao Tate, Masaharu Takada, Shuuji Takahashi, and Michihiko Horie *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 21 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

An overview of the conceptual study on pressurized manned lunar rover to enable the safety operation of exploration crew is presented. Subjects of the operation of the rover were studied to determine its function and property requirements. Operation modes, including mission operation mode and system maintenance mode, and operation profiles, including those for initial assembly and manned missions, were studied to determine requirements from the operational aspects. The system and subsystem structures, including resource distribution and control methods, to meet the function and property requirements were studied. Two types of configurations of the Remote Manipulator Systems (RMS's) were determined. Author (NASDA)

N93-28033# Kawasaki Heavy Industries Ltd., Kobe (Japan).
MANNED LUNAR SURFACE SITE [YUUJIN GETSUMEN KYOTEN] **c54**

Terumitsu Kamata and Hiroyuki Torii *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 17 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

Functions required for environment control system (mainly on air conditioning and air regeneration equipment) for the purpose of calculating their weight and electric power requirement for habitation module of manned lunar surface site were studied. Studies were conducted on subsystem performance requirements to satisfy the required functions and comparison of constituent equipment for the environment control system were conducted to select candidate equipment. Required electric power and weight were calculated and totaled to figure out the weight and electric power requirement of the environment control system. The above studies were conducted on air circulation, temperature and humidity control, and particles and microorganisms removal of air conditioning equipment and CO2 removal and toxic gas processing equipment for air regeneration. Author (NASDA)

N93-28034# Ishikawajima-Harima Heavy Industries Co. Ltd., Tokyo (Japan).
LUNAR SURFACE EXPERIMENT SYSTEM [GETSUMEN JIKKEN SHISUTEMU] **c54**

Masakazu Takami, Seiko Hoshi, and Yuriko Oka *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 22 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

An overview of the study on experiment systems operated at manned lunar surface site is presented. Missions to be conducted at manned lunar surface site were selected by evaluating from the view points of required resources (electric power, weight, and crew man hours), feasibility, operability, and especially significance as the frontier base. Mission performance sites, such as pressurized and exposed (located near habitation module or at remote location) environments, and system structures, including their ingredient subsystems, corresponding to them are outlined. Resource allotment for the experiment system from the lunar surface site, resources required for the missions, and mission crew time for the experiment system were analyzed and the crew time required for experiment operations at manned lunar base was determined. Approximate time required for conducting each mission was studied. A model mission operation and an example of lunar surface experiment system operation (for pressurized environment and near module experiments) are shown. Author (NASDA)

N93-28035# Remote Sensing Technology Center, Tokyo (Japan).
UNMANNED LUNAR SURFACE EXPLORATION [MUJIN GETSUMEN TANSA] **c91**

Hajime Koshiishi and Natsuhiko Motomura *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 18 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

An overview of the study of unmanned lunar surface exploration, including the one for obtaining ground truths for remote sensing and that can not be accomplished without lunar surface activities, for the missions of purely scientific exploration and examining explorations necessary for lunar development and utilization, especially lunar base construction, is presented. In the fields of scientific exploration, the following subjects are outlined: (1) mineral exploration by landing modules and roving vehicles, including acquisition of ground truths for mineral remote sensing, identification of minerals on the lunar surface, x-ray fluorescence analysis equipment and x-ray powder refractometer, etc.; (2) observation of artificial RF (Radio Frequency) wave sources on the lunar surface; (3) lunar earthquake observation; (4) lunar gravity observation; (5) microwave remote sensing of the moon; and (6) acquisition of ground truths for microwave radars, and others. In the fields of explorations for lunar development and utilization, the following subjects are outlined: (1) bearing power of the lunar ground; (2) lunar ground subsidence; (3) difficulty of excavation; and (4) selection of examining methods. Author (NASDA)

N93-28036# National Space Development Agency, Ibaraki (Japan).
CONCEPTUAL STUDY OF THE MOON REVOLVING OBSERVATION SATELLITES [TSUKI SHUUKAI KANSOKU EISEI NO GAINEN KENTOU] **c18**

Takeshi Kawazoe *In its* Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 17 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

An overview of the conceptual study of the moon revolving satellites, for the missions of examining the topography, geology, crest, and water resources in the polar region of the moon, and lunar landing experiments, launched as the first step of the unmanned exploration prior to the future manned space activities is presented. Mission objectives selected for the moon revolving satellites were lunar surface mapping and resources exploration, and soft landing experiment to lunar surface. For the one case selected from four mission cases, 1.5-ton satellite plus 500 kg landing module, the results of the mission analysis, including orbit analysis, data acquisition plan, operation plan and the resource requirements for the system, and system study, including studies on prerequisites, characteristics, weight and electric power distribution, configuration of the system, and system analysis, including analyses on propellant, communication circuits, electric power, and subsystems are outlined. Author (NASDA)

N93-28037# Toshiba Corp., Tokyo (Japan).
MOON REVOLVING OBSERVATION SATELLITES [TSUKI SHUUKAI KANSOKU EISEI] **c18**

Hidenori Nagata, Nobuaki Nagaoka, and Megumi Suzaki *In its* Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 21 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

The major mission objectives for the moon revolving observation satellites are lunar surface mapping and resources exploration, and soft landing experiment to the lunar surface. Missions to accomplish the objectives were studied on two mission cases, 2-ton moon revolving satellite and 1.5-ton moon revolving satellite plus 500 kg landing experiment module. Three kinds of mission models set up for each of the two mission cases are shown. The result of the mission analysis, including analyses on data acquisition and sensor operation plan, and system study, including studies of satellite configuration, and subsystem study, including the studies of attitude and orbit control, and solar paddle subsystems, are outlined.
Author (NASDA)

N93-28038# Nihon ESPEC (Japan).
MOON REVOLVING OBSERVATION SATELLITE [TSUKI SHUUKAI KANSOKU EISEI] **c18**

Reiji Katane and Tsuyoshi Okazaki *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 22 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

An overview of the conceptual study of the moon revolving observation satellites to be launched by the H-2 launch vehicle for lunar surface mapping and resources exploration from a polar orbit at an altitude of 100 km is presented. The results of the mission study, including the studies of mission requirements and mission equipment selection, and mission analysis including analyses on sensor and mission equipment operations, and system study including the studies of system prerequisites, subsystem function allocation, weight and electric power allotment, overall configuration, and sequence of events, and subsystem study are outlined. The outline of satellite-borne equipment, system requirements and prerequisites, satellite weight and power allotment, on-orbit and launching configurations, sequence of events, and the results of the subsystem study are shown.
Author (NASDA)

N93-28039# Institute for Future Technology, Tokyo (Japan).
RESEARCH ON LUNAR RESOURCES DEVELOPMENT AND THEIR UTILIZATION [TSUKI SHIGEN NO KAIHATSU RITOU NO KENKYUU] **c91**

Jun Suzuki *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 22 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

An overview of the results of the research on scientific knowledge on lunar resources, the resources utilization processes, and case study of resources utilization system on the lunar surface are presented. The scientific knowledge about lunar resources, including outline of lunar resource development and utilization, lunar topography and surface environments, physical properties and chemical compositions of the lunar surface soil are outlined. The lunar resource utilization processes such as regolith screening and enrichment, separation of each components (reduction, extraction, and refining), and the results of the case study of resource utilization systems on the lunar surface, including lunar bases and lunar surface activities scenarios, lunar resource utilization strategy, and study subjects are outlined. Author (NASDA)

N93-28040# National Space Development Agency, Tokyo (Japan).
CONCEPTUAL STUDY OF LUNAR ROVING EXPLORER [GETSUMEN IDOU TANSAKI NO GAIKEN KENTOU] **c37**

Yutaka Kaneko *In its* Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 19 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

A conceptual study of lunar roving explorer is described.
Author (NASDA)

N93-28041# Nissan Motor Co. Ltd., Tokyo (Japan). Aerospace Div.
LUNAR SURFACE ROVING EXPLORER [GETSUMEN IDOU TANSAKI] **c37**

Youko Nishio *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 16 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

An overview of the results of a system study of an unmanned lunar surface rover is presented. The rover is to have a mass of 900 kg and to be launched by the H-2 launch vehicle. The system study focussed on functional requirements, algorithms, and the major equipment structure necessary for partially autonomous operation. The results of the mission study are presented. The study included the following: outlines of equipment structure; data capacity of the image processing equipment for lunar topography mapping; mission requirements for analyzing elements of the lunar substances and acquiring characteristic data of regolith, for acquiring environmental data, and for experiments utilizing lunar substances--such as oxygen manufacturing experiment and volatile component retrieval experiment; and metal production and sintering experiments using regolith.
Author (NASDA)

N93-28042# Fujitsu Ltd., Tokyo (Japan).
LUNAR SURFACE ROVING EXPLORER [GETSUMEN IDOU TANSAKI] **c37**

Yasushi Inamoto, Satoshi Ishii, and Toshihiko Morita *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 21 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

Results concerning the conceptual study of the system, the partially autonomous operation of the system, and the partially autonomous activities of the system are presented. Results are presented for the following topics: topographical mapping; regolith sampling operations; and system studies--including roving routes, roving profiles and operation modes, electric power and communication circuit analyses, and the partially autonomous control system study. The major characteristics and the system structure of the lunar surface roving explorer, the functional structure and functional block diagram of the autonomous operation system, and the functional structure and block diagram of the autonomic activities are shown.
Author (NASDA)

N93-28043# Ishikawajima-Harima Heavy Industries Co. Ltd., Tokyo (Japan).
CONCEPTUAL STUDY OF LUNAR LANDING MODULES [GETSUMEN CHAKURIKUKI NO GAINEN KENTOU] **c18**

Koutarou Shiina, Shunichirou Nakai, Yukihito Kitazawa, Tsumeo Kawai, and Kazuyuki Higashino *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 22 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

An overview of the missions, systems, and subsystems of a lunar

rover module, to be launched by the H-2 launch vehicle, is presented. The following topics are discussed: environmental measurement; geological survey of regolith; ground and underground structure surveys; an example of the mission model; the weight and electric power allotments; mission profiles; sequence of events of the landing module; navigation and guidance control; propulsion; thermal control; structure subsystems; landing orbit optimization through the Pontryagin's maximum principle; and an analysis of LH2 evaporation. Author (NASDA)

N93-28044# Tokyo Univ. (Japan). Faculty of Science.
SCIENCE MISSIONS FOR LUNAR RESOURCES EXPLORATION [TSUKI SHIGEN TANSA NO SAIENSU MISSHON NI TSUITE] **c91**
Hiroshi Takeda *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 8 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A02/MF A06

An overview of knowledge, obtained in past missions, concerning the moon is presented. By making use of false-color images, obtained by using onboard filters for wavelengths of 0.41, 0.76, and 0.99 microns, maps corresponding to the lunar geological units can be obtained. It is the knowledge that can be gained from these maps that is outlined. Resource-related, candidate exploration site areas are as follows: (1) areas of regolith that show concentrations of ilmenite; (2) areas deemed adequate for lunar base construction because of sufficient materials for construction; (3) areas where there is anorthosite from which Ca, Al, and Si resources can easily be extracted; (4) areas where KREEP (Potassium-Rare Earth Element-Phosphate Rich Mineral) and granite are densely distributed and ores containing the rare metals, U, Th, and K exist; and (5) areas where fayalite of high specific gravity and spinel-related ores containing Fe and Ti exist. Author (NASDA)

N93-28045# National Space Development Agency, Ibaraki (Japan).
MARS EXPLORATION MISSION [KASEI TANSA MISSHON] **c91**
Kazuo Oota *In its* Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 22 p In ENGLISH and JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

A study that considers optimal mission participation by NASDA in the MESUR and MARSNET missions is presented. Continuous observation of Mars and problems associated with data relay were the primary concerns of the study. Author (NASDA)

N93-28046# National Space Development Agency, Ibaraki (Japan).
DETAIL DESIGN OF MARS TRANSFER ORBIT [KASEI SENI KIDOU SHOUSAI SEKKEI] **c13**
Kazuo Oota, Ken Nakazima, and Koutarou Nagano *In its* Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 20 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

An overview of interplanetary transfer orbit simulations and orbit injections is presented. The process for setting initial values (injection date and orbit elements at the orbit injection) was developed from the values obtained by the conceptual study. The following design concerns are considered: the velocity vector at injection; a transfer orbit that neglects the earth's gravity; the velocity vector upon reaching Mars--neglecting Mars's gravity; velocity increments necessary at perigee and apogee; and and flight time. Necessary speed increments and the Mars true anomaly at the transfer orbit injection were used to determine the transfer orbit injection date.
Author (NASDA)

N93-28047# Hitachi Ltd., Tokyo (Japan).
MARS REVOLVING OBSERVATION SATELLITE [KASEI SHUUKAI KANSOKU EISEI] **c18**
Minako Tajima *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 18 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

A study concerning the possibility of a Mars revolving satellite, to be launched in the first part of the 21st century, is presented. It is believed that this is a necessary step before proceeding to Mars landings, bases, and further exploration. The mission requirements are as follows: (1) a precision Mars mapping, including topography information; (2) a Mars resources exploration by spectral absorption examination of the Mars surface; (3) a Mars atmospheric investigation; (4) a survey of the Mars polar cap; and (5) a radioactive environment survey. The system structure, electric power and weight analysis, and fuel analysis are presented. A subsystem analyses concerning attitude control, communication, electric power, data processing, and propulsion and reaction control subsystems is also provided. Author (NASDA)

N93-28048# Toshiba Corp., Tokyo (Japan).
OUTLINE OF MARS EXPLORER SYSTEM [KASEI TANSAKI SISEMEMU NO GAIYOU] **c37**
Megumi Suzaki *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 21 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

Explorer systems were studied. The specific missions are as follows: Phobos and Deimos sample return, Mars landing explorer, and Mars sample return module. The results of the survey were concerned with restrictions imposed upon the explorer's configuration. The results of the survey were compared with earth revolving satellite missions. Author (NASDA)

N93-28049# European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands).
ROSETTA: THE ESA SAMPLE RETURN MISSION
J. deLafontaine *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 23 p (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

The 'Cornerstone Missions' of ESA's space science program, including the Solar Terrestrial Science Program (STSP), the X-Ray Multi-Mirror (XMM) mission, the Far Infrared Space Telescope (FIRST), and the Rosetta mission are introduced. Specific mission constraints for the Rosetta mission are outlined. The Rosetta mission scenarios are divided into the following seven phases: (1) launch and cruise to comet; (2) comet detection and approach; (3) comet observation; (4) descent and landing; (5) sampling operations; (6) take-off and return cruise; and (7) earth re-entry and recovery. The base-line spacecraft configuration--which is composed of three modules, cruiser, lander, and earth re-entry capsule--is shown. A brief summery of the spacecraft subsystems and the scientific payload is presented.
Author (NASDA)

N93-27043*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
ASTROTECH 21: A TECHNOLOGY PROGRAM FOR FUTURE ASTROPHYSICS MISSIONS
James A. Cutts and George P. Newton (National Aeronautics and Space Administration, Washington, DC.) *In its* Workshop Proceedings: Information Systems for Space Astrophysics in the 21st Century, Volume 1 1 May 1991 p 3-16 (For primary document see N93-27042 10-82)
Avail: CASI HC A03/MF A02

N93-27174 European Space Agency, Paris (France).
EUROPEAN SPACE PROGRAMME Abstract Only
J.-M. Luton *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 56A-56B (For primary document see N93-27166 10-01)
Copyright Avail: Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel

N93-27202 Technion - Israel Inst. of Tech., Haifa.
VERTICAL LANDING ON AN ASTEROID
D. Harel and M. Guelman (Rafael Armament Development Authority, Haifa, Israel.) *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 304-310 (For primary document see N93-27166 10-01)
Copyright Avail: Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel

13 ASTRODYNAMICS

Includes powered and free-flight trajectories; and orbital and launching dynamics.

N93-27609*# Analytical Mechanics Associates, Inc., Hampton, VA.
SOYUZ ESCAPE TRAJECTORY ANALYSIS FROM SPACE STATION FREEDOM
Michael L. Heck Washington NASA May 1993 26 p
(Contract NAS1-18935; RTOP 476-14-15-01)
(NASA-CR-4508; NAS 1.26:4508; Rept-93-1) Avail: CASI HC A03/MF A01

It has been proposed to utilize the Russian built SOYUZ as an assured crew return vehicle (ACRV) for Space Station Freedom. Three departure directions (nadir, zenith, minus velocity) are evaluated to determine escape path clearances. In addition, the effects of the following parameters were also evaluated: delta-V magnitude, configuration dependent ballistic coefficients, atmospheric density, Freedom attitude control, and canted docking adaptors. The primary factor influencing the escape trajectory was station contingency attitude rate. The nadir and zenith departures were preferable to minus velocity. The impact of atmospheric density and relative ballistic coefficients was minimal. Author (revised)

N93-28321*# Dynetics, Inc., Huntsville, AL.
MASTRE TRAJECTORY CODE UPDATE TO AUTOMATE FLIGHT TRAJECTORY DESIGN, PERFORMANCE PREDICTIONS, AND VEHICLE SIZING FOR SUPPORT OF SHUTTLE AND SHUTTLE DERIVED VEHICLES: PROGRAMMERS MANUAL Final Report
Apr. 1993 583 p
(Contract NAS8-38981)
(NASA-CR-192558; NAS 1.26:192558; TR-93-061) Avail: CASI HC A25/MF A06

The information required by a programmer using the Minimum Hamiltonian AScent Trajectory Evaluation (MASTRE) Program is provided. This document enables the programmer to either modify the program or convert the program to computers other than the VAX computer. Documentation for each subroutine or function based on providing the definitions of the variables and a source listing are included. Questions concerning the equations, techniques, or input requirements should be answered by either the Engineering or User's manuals. Three appendices are also included which provide a listing of the Root-Sum-Square (RSS) program, a listing of subroutine names and definitions used in the MASTRE User Friendly Interface Program, and listing of the subroutine names and definitions used in the Mass Properties Program. The RSS Program is used to aid in the performance of dispersion analyses. The RSS program reads a file generated by the MASTRE Program, calculates dispersion parameters, and generates output tables and output plot files. UFI Program provides a screen user interface to aid the user in providing input to the model. The Mass Properties Program defines the mass properties data for the MASTRE program through the use of user interface software.
Author (revised)

N93-28395# Naval Postgraduate School, Monterey, CA.
AN EXPERT SYSTEM FOR PROCESSING UNCORRELATED SATELLITE TRACKS M.S. Thesis
Michael A. Hecker 17 Dec. 1992 240 p
(AD-A262713) Avail: CASI HC A11/MF A03

Through an array of ground based radar sights and optical cameras, the United States military tracks objects in near and far Earth orbit. The sensors provide epoch and ephemeris information that is used to update a database of known objects. While a majority of the sensor observations are matched to their corresponding satellites, a small percentage are beyond the capabilities of current software and cannot be correlated. These uncorrelated targets, UCT's, must be manually fitted by orbital analysts in a labor intensive process. As an alternative to this human intervention, the use of artificial intelligence techniques to augment the present computer code was explored. Specifically, an expert system for processing UCT's at the Naval Space Surveillance Command was developed. Rules were generated through traditional knowledge engineering methods and by a novel application of machine learning. The initial results are very good with the operational portions of the system matching the performance of the experts with an accuracy of 99%. Although not yet complete, the code developed in this research definitely shows the potential of using artificial intelligence to process UCT'S. DTIC

N93-27204 Technion - Israel Inst. of Tech., Haifa. Faculty of Aerospace Engineering.
INTERACTIVE METHOD FOR PLANNING CONSTRAINED FUEL OPTIMAL PROXIMITY OPERATIONS
A. Abramovitz and A. Grunwald *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 318-329 (For primary document see N93-27166 10-01)
Copyright Avail: Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel

N93-27205 Tel-Aviv Univ. (Israel). Dept. of Electronic Systems.
MINIMUM EFFORT INTERCEPTION OF MULTIPLE TARGETS
Joseph Z. Ben-Asher *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 330-334 (For primary document see N93-27166 10-01)
Copyright Avail: Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel

N93-28046# National Space Development Agency, Ibaraki (Japan).
DETAIL DESIGN OF MARS TRANSFER ORBIT [KASEI SENI KIDOU SHOUSAI SEKKEI]
Kazuo Oota, Ken Nakazima, and Koutarou Nagano *In its* Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 20 p
In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

14 GROUND SUPPORT SYSTEMS AND FACILITIES (SPACE)

Includes launch complexes, research and production facilities; ground support equipment, e.g., mobile transporters; and simulators.

For related information see also *09 Research and Support Facilities (Air).*

N93-26963*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
FACILITIES
In its Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 741-742 (For primary document see N93-26951 10-20)
Avail: CASI HC A01/MF A06

N93-26964*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
PLUM BROOK FACILITIES
Robert Kozar *In its* Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 743-745 (For primary document see N93-26951 10-20)
Avail: CASI HC A01/MF A06

N93-26965*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
NEP FACILITIES (LERC)
Robert H. Vetrone *In its* Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 746-751 (For primary document see N93-26951 10-20)
Avail: CASI HC A02/MF A06

N93-26966*# Los Alamos National Lab., NM. Field Test Div.
LOS ALAMOS STUDIES OF THE NEVADA TEST SITE FACILITIES FOR THE TESTING OF NUCLEAR ROCKETS
Michael V. Hynes *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 752-757 (For primary document see N93-26951 10-20)
Avail: CASI HC A02/MF A06

N93-26967*# Idaho National Engineering Lab., Idaho Falls.
SPACE NUCLEAR THERMAL PROPULSION: EVALUATION OF PIPET AT THE INEL'S CTF
Thomas J. Hill *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 758-764 (For primary document see N93-26951 10-20)
Avail: CASI HC A02/MF A06

N93-26968*# Phillips Lab., Edwards AFB, CA.
SPACE NUCLEAR THERMAL PROPULSION (SNTP) AIR FORCE FACILITY
David F. Beck *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 765-776 Prepared in cooperation with Grumman Aerospace Corp., Bethpage, NY; Babcock and Wilcox Co., Lynchburg, VA; Brookhaven National Lab., Upton, NY; and Sandia National Labs., Albuquerque, NM (For primary document see N93-26951 10-20)
Avail: CASI HC A03/MF A06

N93-26969*# Sandia National Labs., Albuquerque, NM. Nuclear Technology Dept.
EFFLUENT TREATMENT FOR NUCLEAR THERMAL PROPULSION GROUND TESTING
Larry R. Shipers *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 777-788 (For primary document see N93-26951 10-20)
Avail: CASI HC A03/MF A06

N93-26970*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
NUCLEAR ELECTRIC PROPULSION SYSTEMS OVERVIEW
Michael P. Doherty *In its* Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 790-797 (For primary document see N93-26951 10-20)
Avail: CASI HC A02/MF S06

N93-27201 Israel Aircraft Industries Ltd., Yehud. Space Technology Dept.
DEVELOPMENT OF IR RADIATION SIMULATOR FOR SPACECRAFT THERMAL TESTING
Yoram Shimrony, Zachary Bachmutsky, Yaron Naimark, and Sylvia Zalmanovich *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 295-303 (For primary document see N93-27166 10-01)
Copyright Avail: Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel

N93-27566*# Aura Systems, Inc., Los Angeles, CA.
MULTIPLE DEGREE-OF-FREEDOM FORCE AND MOMENT MEASUREMENT FOR STATIC PROPULSION TESTING USING MAGNETIC SUSPENSION TECHNOLOGY
Keith Stuart and Blake Bartosh *In* NASA. Langley Research Center, Magnetic Suspension Technology Workshop 1993 p 183-196 (For primary document see N93-27554 10-18)
Avail: CASI HC A03/MF A03

15 LAUNCH VEHICLES AND SPACE VEHICLES

Includes boosters; operating problems of launch/space vehicle systems; and reusable vehicles.

For related information see also *20 Spacecraft Propulsion and Power.*

N93-27016*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ANALYSIS OF THE STAGING MANEUVER AND BOOSTER GLIDEBACK GUIDANCE FOR A TWO-STAGE, WINGED, FULLY REUSABLE LAUNCH VEHICLE M.S. Thesis - George Washington Univ.
J. Christopher Naftel and Richard W. Powell Washington Apr. 1993 25 p
(RTOP 906-11-01-01)
(NASA-TP-3335; L-17066; NAS 1.60:3335) Avail: CASI HC A03/MF A01

One of the promising launch concepts that could replace the current space shuttle launch system is a two-stage, winged, vertical-takeoff, fully reusable launch vehicle. During the boost phase of ascent, the booster provides propellant for the orbiter engines through a cross-feed system. When the vehicle reaches a Mach number of 3, the booster propellants are depleted and the booster is staged and glides unpowered to a horizontal landing at a launch site runway. Two major design issues for this class of vehicle are the staging maneuver and the booster glideback. For the staging maneuver analysis, a technique was developed that provides for a successful separation of the booster from the orbiter over a wide range of staging angles of attack. A longitudinal flight control system was developed for control of the booster during the staging maneuver. For the booster glide back analysis, a guidance algorithm was developed that successfully guides the booster from the completion of the staging maneuver to a launch site runway while encountering many off-nominal atmospheric, aerodynamic, and staging conditions. Author (revised)

N93-27018*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
THE DESIGN AND EVOLUTION OF THE BETA TWO-STAGE-TO-ORBIT HORIZONTAL TAKEOFF AND LANDING LAUNCH SYSTEM
Leo A. Burkardt and Rick B. Norris (Wright Lab., Wright-Patterson AFB, OH.) Dec. 1992 18 p Presented at the Fourth International Aerospace Planes Conference, Orlando, FL, 1-4 Dec. 1992; sponsored by AIAA Previously announced in IAA as A93-22350
(RTOP 505-69-40)
(NASA-TM-106118; E-7776; NAS 1.15:106118; AIAA Paper 92-5080)
Avail: CASI HC A03/MF A01

The Beta launch system was originally conceived in 1986 as a horizontal takeoff and landing, fully reusable, two-stage-to-orbit, manned launch vehicle to replace the Shuttle. It was to be capable of delivering a 50,000 lb. payload to low polar orbit. The booster propulsion system consisted of JP fueled turbojets and LH fueled ramjets mounted in pods in an over/under arrangement, and a single LOX/LH fueled SSME rocket. The second stage orbiter, which staged at Mach 8, was powered by an SSME rocket. A major goal was to develop a vehicle design consistent with near term technology. The vehicle design was completed with a GLOW of approximately 2,000,000 lbs. All design goals were met. Since then, interest has shifted to the 10,000 lbs. to low polar orbit payload class. The original Beta was down-sized to meet this payload class. The GLOW of the down-sized vehicle was approximately 1,000,000 lbs. The booster was converted to exclusively air-breathing operation. Because the booster depends on conventional air-breathing propulsion only, the staging Mach number was reduced to 5.5. The orbiter remains an SSME rocket-powered stage.
Author

N93-27261*# North Carolina State Univ., Raleigh. Dept. of Electrical and Computer Engineering.
MOMENT METHOD ANALYSIS OF LINEARLY TAPERED SLOT ANTENNAS Final Report, 15 Jan. 1989 - 30 Sep. 1991
Adnan Koeksal Jun. 1993 97 p
(Grant NAG1-943; RTOP 506-59-64-01)
(NASA-CR-191474; NAS 1.26:191474) Avail: CASI HC A05/MF A02

A method of moments (MOM) model for the analysis of the Linearly Tapered Slot Antenna (LTSA) is developed and implemented. The model employs an unequal size rectangular sectioning for conducting parts of the antenna. Piecewise sinusoidal basis functions are used for the expansion of conductor current. The effect of the dielectric is incorporated in the model by using equivalent volume polarization current density and solving the equivalent problem in free-space. The feed section of the antenna including the microstripline is handled rigorously in the MOM model by including slotline short circuit and microstripline currents among the unknowns. Comparison with measurements is made to demonstrate the validity of the model for both the air case and the dielectric case. Validity of the model is also verified by extending the model to handle the analysis of the skew-plate antenna and comparing the results to those of a skew-segmentation modeling results of the same structure and to available data in the literature. Variation of the radiation pattern for the air LTSA

with length, height, and taper angle is investigated, and the results are tabulated. Numerical results for the effect of the dielectric thickness and permittivity are presented. Author (revised)

N93-28052*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
QUALITATIVE MODEL-BASED DIAGNOSTICS FOR ROCKET SYSTEMS
William Maul (Sverdrup Technology, Inc., Brook Park, OH.), Claudia Meyer (Sverdrup Technology, Inc., Brook Park, OH.), Amy Jankovsky, and Christopher Fulton (Analex Corp., Brook Park, OH.) Jun. 1993 13 p Presented at the 29th Joint Propulsion Conference and Exhibit, Monterey, CA, 28-30 Jun. 1993; sponsored by AIAA, SAE, ASME, and ASEE
(RTOP 584-03-11)
(NASA-TM-106234; E-7954; NAS 1.15:106234; AIAA Paper 93-1779)
Avail: CASI HC A03/MF A01

A diagnostic software package is currently being developed at NASA LeRC that utilizes qualitative model-based reasoning techniques. These techniques can provide diagnostic information about the operational condition of the modeled rocket engine system or subsystem. The diagnostic package combines a qualitative model solver with a constraint suspension algorithm. The constraint suspension algorithm directs the solver's operation to provide valuable fault isolation information about the modeled system. A qualitative model of the Space Shuttle Main Engine's oxidizer supply components was generated. A diagnostic application based on this qualitative model was constructed to process four test cases: three numerical simulations and one actual test firing. The diagnostic tool's fault isolation output compared favorably with the input fault condition. Author (revised)

16 SPACE TRANSPORTATION

Includes passenger and cargo space transportation, e.g., shuttle operations; and space rescue techniques.

For related information see also *03 Air Transportation and Safety* and *18 Spacecraft Design, Testing and Performance*. For space suits see *54 Man/System Technology and Life Support*.

N93-27538*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
DEBRIS/ICE/TPS ASSESSMENT AND INTEGRATED PHOTOGRAPHIC ANALYSIS FOR SHUTTLE MISSION STS-56 Final Report, 4-18 Apr. 1993
Gregory N. Katnik, Barry C. Bowen, J. Bradley Davis, Jorge E. Rivera, and Robert F. Speece May 1993 157 p Original contains color illustrations
(NASA-TM-107560; NAS 1.15:107560) Avail: CASI HC A08/MF A02; 61 functional color pages

The Debris Team developed and implemented measures to control damage from debris in the Shuttle operational environment and to make the control measures a part of routine launch flows. These measures include engineering surveillance during vehicle processing and closeout operations, facility and flight hardware inspections before and after launch, and photographic analysis of mission events. Photographic analyses of mission imagery from launch, on-orbit, and landing provide significant data in verifying proper operation of systems and evaluating anomalies. In addition to the Kennedy Space Center (KSC) Photo/Video Analysis, reports from JSC, MSFC, and Rockwell International--Downey are also included in this document to provide an integrated assessment of the mission.
Author (revised)

N93-27693# Air Force Systems Command, Wright-Patterson AFB, OH. Foreign Aerospace Science and Technology Center.
INVESTIGATION OF SEPARATION IN A STRAP-ON SPACE SHUTTLE SYSTEM
Zhang Lumin and Liu Sen 25 Feb. 1993 18 p Transl. into ENGLISH from Kongqidonglixue Xuebao (China), v. 8, no. 2, 1990 p 174-180
(AD-A262372; FASTC-ID(RS)T-0854-92) Avail: CASI HC A03/MF A01

Separation research on the Shuttle Orbiter/External Tank and the Shuttle Orbiter/Booster is described. The analytical model of separation is presented for the parallel Space Shuttle system with the perpendicular launch. Meanwhile, the important problems of the safe separation are presented. The separation of the parallel Space Shuttle system is a key technique in the future space technical fields. Our capability of resolving separation is described, and the method of resolving separation is provided in this paper. DTIC

N93-28030# Mitsubishi Heavy Industries Ltd., Tokyo (Japan).
CONCEPTUAL STUDY OF MANNED LUNAR TRANSPORTATION SYSTEM [YUUJIN TSUKI YUSOU SHISUTEMU NO KOUSOU KENTOU]
Takahiro Itou *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 15 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

17 SPACE COMM., SPACECRAFT COMM., COMMAND & TRACKING

Includes telemetry; space communications networks; astronavigation and guidance; and radio blackout.

For related information see also *04 Aircraft Communications and Navigation* and *32 Communications and Radar*.

N93-26895*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
FAULT-TOLERANT ONBOARD DIGITAL INFORMATION SWITCHING AND ROUTING FOR COMMUNICATIONS SATELLITES
Mary Jo Shalkhauser, Jorge A. Quintana, Nitin J. Soni, and Heechul Kim Washington Apr. 1993 11 p
(RTOP 506-72-21)
(NASA-TM-4471; E-7332; NAS 1.15:4471) Avail: CASI HC A03/MF A01

The NASA Lewis Research Center is developing an information-switching processor for future meshed very-small-aperture terminal (VSAT) communications satellites. The information-switching processor will switch and route baseband user data onboard the VSAT satellite to connect thousands of Earth terminals. Fault tolerance is a critical issue in developing information-switching processor circuitry that will provide and maintain reliable communications services. In parallel with the conceptual development of the meshed VSAT satellite network architecture, NASA designed and built a simple test bed for developing and demonstrating baseband switch architectures and fault-tolerance techniques. The meshed VSAT architecture and the switching demonstration test bed are described, and the initial switching architecture and the fault-tolerance techniques that were developed and tested are discussed. Author (revised)

N93-27064*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
UTILIZING A TDRS SATELLITE FOR DIRECT BROADCAST SATELLITE-RADIO PROPAGATION EXPERIMENTS AND DEMONSTRATIONS
James E. Hollansworth Jun. 1993 16 p Presented at the Third International Mobile Satellite Conference and Exhibition, Pasadena, CA, 16-18 Jun. 1993
(RTOP 106-70-00)
(NASA-TM-106172; E-7872; NAS 1.15:106172) Avail: CASI HC A03/MF A01

The NASA/VOA Direct Broadcast Satellite-Radio (DBS-R) Program will be using a NASA Tracking Data Relay Satellite (TDRS) satellite at 62 deg. West longitude to conduct live satellite S-band propagation experiments and demonstrations of satellite sound broadcasting over the next two years (1993-1994). The NASA/VOA DBS-R program has applied intensive effort to garner domestic and international support for the DBS-R concept. An S-band DBS-R allocation was achieved for Region 2 at WARC-92 held in Spain. With this allocation, the DBS-R program now needs to conduct S-band propagation experiments and systems demonstrations that will assist in the development of planning approaches for the use of Broadcast Satellite Service (Sound) frequency bands prior to the planning conference called for by WARC-92. These activities will also support receiver concept development applied to qualities ranging from AM to Monophonic FM, Stereophonic FM, Monophonic CD, and Stereophonic CD quality. Author

N93-27592*# Dynetics, Inc., Huntsville, AL. Systems Analysis and Engineering Dept.
MINIMUM HAMILTONIAN ASCENT TRAJECTORY EVALUATION (MASTRE) PROGRAM (UPDATE TO AUTOMATIC FLIGHT TRAJECTORY DESIGN, PERFORMANCE PREDICTION, AND VEHICLE SIZING FOR SUPPORT OF SHUTTLE AND SHUTTLE DERIVED VEHICLES) ENGINEERING MANUAL Final Report
J. T. Lyons Apr. 1993 135 p
(Contract NAS8-38981)
(NASA-CR-192557; NAS 1.26:192557; TR-93-042) Avail: CASI HC A07/MF A02

The Minimum Hamiltonian Ascent Trajectory Evaluation (MASTRE) program and its predecessors, the ROBOT and the RAGMOP programs, have had a long history of supporting MSFC in the simulation of space boosters for the purpose of performance evaluation. The ROBOT program was used in the simulation of the Saturn 1B and Saturn 5 vehicles in the 1960's and provided the first utilization of the minimum Hamiltonian (or min-H) methodology and the steepest ascent technique to solve the optimum trajectory problem. The advent of the Space Shuttle in the 1970's and its complex airplane design required a redesign of the trajectory simulation code since aerodynamic flight and controllability were required for proper simulation. The RAGMOP program was the first attempt to incorporate the complex equations of the Space Shuttle into an optimization tool by using an optimization method based on steepest ascent techniques (but without the min-H methodology). Development of the complex partial derivatives associated with the Space Shuttle configuration and using techniques from the RAGMOP program, the ROBOT program was redesigned to incorporate these additional complexities. This redesign created the MASTRE program, which was referred to as the Minimum Hamiltonian Ascent Shuttle TRajectory Evaluation program at that time. Unique to this program were first-stage (or booster) nonlinear aerodynamics, upper-stage linear aerodynamics, engine control via moment balance, liquid and solid thrust forces, variable liquid throttling to maintain constant acceleration limits, and a total upgrade of the equations used in the forward and backward integration segments of the program. This modification of the MASTRE code has been used to simulate the new space vehicles associated with the National Launch Systems (NLS). Although not as complicated as the Space Shuttle, the simulation and analysis of the NLS vehicles required additional modifications to the MASTRE program in the areas of providing additional flexibility in the use of the program, allowing additional optimization options, and providing special options for the NLS configuration. Derived from text

N93-27681# Woods Hole Oceanographic Inst., MA.
ARRAY DATA ACQUISITION WITH WIRELESS LAN TELEMETRY AS APPLIED TO SHALLOW WATER TOMOGRAPHY IN THE BARENTS SEA Technical Report
K. vonderHeydt, J. Kemp, J. Lynch, J. Miller, and C. S. Chiu Dec. 1992 39 p
(Contracts N00123-92-C-0071; N00014-91-J-1246)
(AD-A262183; WHOI-92-44) Avail: CASI HC A03/MF A01

This report describes the application of a new technique of digital radio telemetry, based on a recently available wireless Local Area Network Ethernet adapter, to the need for realtime transmission of data from a vertical line array (VLA) of hydrophones to a nearby ship. The report is technical in nature and discusses the design and performance of the system as used during the Barents Sea Polar Front Experiment in August 1992. A key feature of the use of LAN technology in a telemetry application is the availability of Transmission Control Protocol (TCP) software for Ethernet hardware that greatly eases the task of achieving error free digital data over a radio link prone to dropouts. DTIC

N93-28416*# Communications Center, Clarksburg, MD.
INFORMATION SWITCHING PROCESSOR (ISP) CONTENTION ANALYSIS AND CONTROL Final Report
D. Shyy and T. Inukai May 1993 84 p
(Contract NAS3-25933; RTOP 506-72-21)
(NASA-CR-191130; E-7858; NAS 1.26:191130) Avail: CASI HC A05/MF A01

Future satellite communications, as a viable means of communications and an alternative to terrestrial networks, demand flexibility and low end-user cost. On-board switching/processing satellites potentially provide these features, allowing flexible interconnection among multiple spot beams, direct to the user communications services using very small aperture terminals (VSAT's), independent uplink and downlink access/transmission system designs optimized to user's traffic requirements, efficient TDM downlink transmission, and better link performance. A flexible switching system on the satellite in conjunction with low-cost user terminals will likely benefit future satellite network users. Author (revised)

18 SPACECRAFT DESIGN, TESTING AND PERFORMANCE

Includes satellites; space platforms; space stations; spacecraft systems and components such as thermal and environmental controls; and attitude controls.

For life support systems see *54 Man/System Technology and Life Support.* For related information see also *05 Aircraft Design, Testing and Performance, 39 Structural Mechanics,* and *16 Space Transportation.*

N93-27019*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
THE EFFECTS OF SIMULATED LOW EARTH ORBIT ENVIRONMENTS ON SPACECRAFT THERMAL CONTROL COATINGS
Joyce A. Dever, Sharon K. Rutledge, Eric J. Bruckner (Cleveland State Univ., OH.), Curtis R. Stidham (Sverdrup Technology, Inc., Brook Park, OH.), Thomas J. Stueber (Sverdrup Technology, Inc., Brook Park, OH.), and Roy E. Booth (Vought Corp., Dallas, TX.) May 1993 18 p Presented at the 38th International SAMPE Symposium and Exhibition, Anaheim, CA, 10-13 May 1993; sponsored by the Society for the Advancement of Materials and Process Engineering
(RTOP 474-46-10)
(NASA-TM-106146; E-7829; NAS 1.15:106146) Avail: CASI HC A03/MF A01

Candidate Space Station Freedom radiator coatings including Z-93, YB-71, anodized aluminum and SiO(x) coated silvered Teflon have been characterized for optical properties degradation upon exposure to environments containing atomic oxygen, vacuum ultraviolet (VUV) radiation, and/or silicone contamination. YB-71 coating showed a blue-gray discoloration, which has not been observed in space, upon exposure in atomic oxygen facilities which also provide exaggerated VUV radiation. This is evidence that damage mechanisms occur in these ground laboratory facilities which are different from those which occur in space. Radiator coatings exposed to an electron cyclotron resonance (ECR) atomic oxygen source in the presence of silicone-containing samples showed severe darkening from the intense VUV radiation provided by the ECR and from silicone contamination. Samples exposed to atomic oxygen from the ECR source and to VUV lamps, simultaneously, with in situ reflectance measurement, showed that significantly greater degradation occurred when samples received line-of-site ECR beam exposure than when samples were exposed to atomic oxygen scattered off of quartz surfaces without line-of-site view of the ECR beam. For white paints, exposure to air following atomic oxygen/VUV exposure reversed the darkening due to VUV damage. This illustrates the importance of in situ reflectance measurement. Author

N93-27023*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
TSS TETHER CABLE METEOROID/ORBITAL DEBRIS DAMAGE ANALYSIS
K. B. Hayashida and J. H. Robinson Apr. 1993 29 p
(NASA-TM-108404; NAS 1.15:108404) Avail: CASI HC A03/MF A01

This report summarizes the damage analyses performed on the tether cable used for the tethered satellite system (TSS), for the damage that could be caused by meteoroid or orbital debris impacts. The TSS consists of a tethered satellite deployer and a tethered satellite. The analytical studies were performed at Marshall Space Flight Center (MSFC) with the results from the following tests: (1) hypervelocity impact tests to determine the 'critical' meteoroid particle diameter, i.e., the maximum size of a meteoroid particle which can impact the tether cable without causing 'failure'; (2) electrical resistance tests on the damaged and undamaged tether cable to determine if degradation of current flow occurred through the damaged tether cables; and (3) tensile load tests to verify the load carrying capability

of the damaged tether cables. Finally, the HULL hydrodynamic computer code was used to simulate the hypervelocity impact of the tether cable by particles at velocities higher than can be tested, to determine the extent of the expected tether damage. Author

N93-27038*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

BATTERY SELECTION FOR SPACE SHUTTLE EXPERIMENTS

David R. Francisco Apr. 1993 14 p

(RTOP 694-03-03)

(NASA-TM-106142; E-7822; NAS 1.15:106142) Avail: CASI HC A03/MF A01

This paper will delineate the criteria required for the selection of batteries as a power source for space experiments. Four basic types of batteries will be explored, lead acid, silver zinc, alkaline manganese, and nickel cadmium. A detailed description of the lead acid and silver zinc cells and a brief exploration of the alkaline manganese and nickel cadmium will be given. The factors involved in battery selection such as packaging, energy density, discharge voltage regulation, and cost will be thoroughly examined. The pros and cons of each battery type will be explored. Actual laboratory test data acquired for the lead acid and silver zinc cell will be discussed. This data will include discharging under various temperature conditions, after three months of storage, and with different types of loads. The lifetime and number of charge/discharge cycles will also be discussed. A description of the required maintenance for each type of battery will be investigated. Author (revised)

N93-27081*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

ENHANCED PLASMA CURRENT COLLECTION FROM WEAKLY CONDUCTING SOLAR ARRAY BLANKETS

G. Barry Hillard May 1993 23 p

(RTOP 506-48-2B)

(NASA-TM-106168; E-7860; NAS 1.15:106168) Avail: CASI HC A03/MF A01

Among the solar cell technologies to be tested in space as part of the Solar Array Module Plasma Interactions Experiment (SAMPIE) will be the Advanced Photovoltaic Solar Array (APSA). Several prototype twelve cell coupons were built for NASA using different blanket materials and mounting techniques. The first conforms to the baseline design for APSA which calls for the cells to be mounted on a carbon loaded Kapton blanket to control charging in GEO. When deployed, this design has a flexible blanket supported around the edges. A second coupon was built with the cells mounted on Kapton-H, which was in turn cemented to a solid aluminum substrate. A final coupon was identical to the latter but used germanium coated Kapton to control atomic oxygen attack in LEO. Ground testing of these coupons in a plasma chamber showed considerable differences in plasma current collection. The Kapton-H coupon demonstrated current collection consistent with exposed interconnects and some degree of cell snapover. The other two coupons experienced anomalously large collection currents. This behavior is believed to be a consequence of enhanced plasma sheaths supported by the weakly conducting carbon and germanium used in these coupons. The results reported here are the first experimental evidence that the use of such materials can result in power losses to high voltage space power systems. Author

N93-27083*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

ROBUST CONTROLLER DESIGN FOR FLEXIBLE STRUCTURES USING NORMALIZED COPRIME FACTOR PLANT DESCRIPTIONS

Ernest S. Armstrong Washington May 1993 72 p

(RTOP 585-03-11-05)

(NASA-TP-3325; L-17179; NAS 1.60:3325) Avail: CASI HC A04/MF A01

Stabilization is a fundamental requirement in the design of feedback compensators for flexible structures. The search for the largest neighborhood around a given design plant for which a single controller produces closed-loop stability can be formulated as an H(sub infinity) control problem. The use of normalized coprime factor plant descriptions, in which the plant perturbations are defined as additive modifications to the coprime factors, leads to a closed-form expression for the maximum neighborhood boundary allowing optimal and suboptimal H(sub infinity) compensators to be computed directly without the usual gamma iteration. A summary of the theory on robust stabilization using normalized coprime factor plant descriptions is presented, and the application of the theory to the computation of robustly stable compensators for the phase version of the Control-Structures Interaction (CSI) Evolutionary Model is described. Results from the application indicate that the suboptimal version of the theory has the potential of providing the bases for the computation of low-authority compensators that are robustly stable to expected variations in design model parameters and additive unmodeled dynamics. Author (revised)

N93-27143*# Mitre Corp., Houston, TX. Center for Civil Systems.

INTEGRATED STATION EXECUTIVE REQUIREMENTS AND SYSTEMS DESIGN APPROACH

Eugene L. Berger and C. Doug Morris Nov. 1992 235 p

(Contract NAS9-18057; Proj. 3100M)

(NASA-CR-185708; NAS 1.26:185708; WP-92W0000302; MTR-92W0000247) Avail: CASI HC A11/MF A03

The Avionics Office of the Space Station Projects Office at Johnson Space Center (JSC) is working to define and integrate end-to-end requirements for the Space Station Freedom Program (SSFP) space-ground operations. As part of these efforts, the project office has had the MITRE Corporation perform assessments and analyses in areas where they had particular concern. These areas include the changing concepts for test methodologies, the operation and performance of the communication protocols, end-to-end network management, and the Master Objects Data Base (MODB). Since the recent restructure of the space station design, a new software application, the Integrated Station Executive (ISE), has been established. This application is to act as an executive agent along with the crew and ground controllers, while replacing (or absorbing) many of the system management functions that required a home when distributed element management was eliminated. This document summarizes the current state of the ISE requirements and assesses the characteristics of the current design. MITRE's goals in this assessment and analysis is twofold: first, identify any internal inconsistencies in either the requirements or in the current design; and second, to examine the applicability of the Open System Interconnection (OSI) management standards. Inasmuch as the ISE has been defined as the executive or operations manager application within the integrated avionics of the space station, special attention is given to adapting OSI management for the specification of the ISE functions.

Author

N93-27147*# Teledyne Brown Engineering, Huntsville, AL.

EXPERIMENT/FACILITY REQUIREMENTS DOCUMENT FOR THE SPACE STATION FURNACE FACILITY. SECTION 1: INTEGRATED CONFIGURATION Final Report

May 1992 350 p

(Contract NAS8-38077)

(NASA-CR-192533; NAS 1.26:192533) Avail: CASI HC A15/MF A03

The function of the Space Station Furnace Facility (SSFF) is to support materials research into the crystal growth and solidification processes of electronic and photonic materials, metals and alloys, and glasses and ceramics. To support this broad base of research requirements, the SSFF will employ a variety of furnace modules which will be operated, regulated, and supported by a core of common subsystems. Furnace modules may be reconfigured or specifically developed to provide unique solidification conditions for each set of experiments. The SSFF modular approach permits the addition of new or scaled-up furnace modules to support the evolution of the facility as new science requirements are identified. The SSFF Core is of modular design to permit augmentation for enhanced capabilities. The fully integrated configuration of the SSFF will consist of three racks with the capability of supporting up to two furnace modules per rack. The initial configuration of the SSFF will consist of two of the three racks and one furnace module. This Experiment/Facility Requirements Document (E/FRD) describes the integrated facility requirements for the Space Station Freedom (SSF) Integrated Configuration-1 (IC1) mission. The IC1 SSFF will consist of two racks: the Core Rack, with the centralized subsystem equipment; and the Experiment Rack-1, with Furnace Module-1 and the distributed subsystem equipment to support the furnace. The SSFF support functions are provided by the following Core subsystems: power conditioning and distribution subsystem (SSFF PCDS); data management subsystem (SSFF DMS); thermal control Subsystem (SSFF TCS); gas distribution subsystem

(SSFF GDS); and mechanical structures subsystem (SSFF MSS).
Author (revised)

N93-27162*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
THE DYNAMIC PHENOMENA OF A TETHERED SATELLITE: NASA'S FIRST TETHERED SATELLITE MISSION, TSS-1
R. S. Ryan, D. K. Mowery, and D. D. Tomlin May 1993 119 p
Sponsored by NASA, Washington
(NASA-TP-3347; M-719; NAS 1.60:3347) Avail: CASI HC A06/MF A02

The tethered satellite system (TSS) was envisioned as a means of extending a satellite from its base (space shuttle, space station, space platform) into a lower or higher altitude in order to more efficiently acquire data and perform science experiments. This is accomplished by attaching the satellite to a tether, deploying it, then reeling it in. When its mission is completed, the satellite can be returned to its base for reuse. If the tether contains a conductor, it can also be used as a means to generate and flow current to and from the satellite to the base. When current is flowed, the tether interacts with the Earth's magnetic field, deflecting the tether. When the current flows in one direction, the system becomes a propulsive system that can be used to boost the orbiting system. In the other direction, it is a power generating system. Pulsing the current sets up a dynamic oscillation in the tether, which can upset the satellite attitude and preclude docking. A basic problem occurs around 400-m tether length, during satellite retrieval when the satellite's pendulous (rotational) mode gets in resonance with the first lateral tether string mode. The problem's magnitude is determined by the amount of skiprope present coming into this resonance condition. This paper deals with the tethered satellite, its dynamic phenomena, and how the resulting problems were solved for the first tethered satellite mission (TSS-1). Proposals for improvements for future tethered satellite missions are included. Results from the first tethered satellite flight are summarized. Author

N93-27260*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ELECTRICAL DESIGN OF SPACE SHUTTLE PAYLOAD G-534: THE POOL BOILING EXPERIMENT
David R. Francisco May 1993 15 p
(RTOP 694-03-03)
(NASA-TM-106143; E-7824; NAS 1.15:106143) Avail: CASI HC A03/MF A01

Payload G-534, the Pool Boiling Experiment (PBE), is a Get Away Special (GAS) payload that flew on the Space Shuttle Spacelab Mission J (STS 47) on September 19-21, 1992. This paper will give a brief overall description of the experiment with the main discussion being the electrical design with a detailed description of the power system and interface to the GAS electronics. The batteries used and their interface to the experiment Power Control Unit (PCU) and GAS electronics will be examined. The design philosophy for the PCU will be discussed in detail. The criteria for selection of fuses, relays, power semiconductors, and other electrical components along with grounding and shielding policy for the entire experiment are presented. The intent of this paper is to discuss the use of military tested parts and basic design guidelines to build a quality experiment for minimal additional cost. Author (revised)

N93-27554*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
MAGNETIC SUSPENSION TECHNOLOGY WORKSHOP
Claude R. Keckler, ed., Nelson J. Groom, ed., and Colin P. Britcher, ed. (Old Dominion Univ., Norfolk, VA.) 1993 380 p Workshop held in Hampton, VA, 2-4 Feb. 1988
(NASA-CP-3202; NAS 1.55:3202) Avail: CASI HC A17/MF A03

In order to identify the state of magnetic suspension technology in such areas as rotating systems, pointing of experiments or subsystems, payload isolation, and superconducting materials, a workshop on Magnetic Suspension Technology was held at the Langley Research Center in Hampton, Virginia, on 2-4 Feb. 1988. The workshop included five technical sessions in which a total of 24 papers were presented. The technical sessions covered the areas of pointing, isolation, and measurement, rotating systems, modeling and control, and superconductors. A list of attendees is provided. For individual titles, see N93-27555 through N93-27578.

N93-27555*# Honeywell, Inc., Glendale, AZ. Satellite Systems Div.
MAGNETIC SUSPENSION ACTUATOR CONCEPTS AND APPLICATIONS
John Kroeger *In* NASA. Langley Research Center, Magnetic Suspension Technology Workshop 1993 p 5-15 (For primary document see N93-27554 10-18)
Avail: CASI HC A03/MF A03

The fundamental aspect which makes magnetic suspension systems possible is the magnetic phenomena by which significant forces can be generated. Each of these force-producing phenomena has unique characteristics and is implementable in a unique fashion, such that each performs the magnetic suspension task differently than the others. A practical overview of the force-producing concepts, their unique characteristics, and their typical methods of application is provided. Author (revised)

N93-27556*# Proto-Technology Corp., Groton, CT.
MAGNETIC BEARINGS: FIFTY YEARS OF PROGRESS **c37**
Michael K. Swann *In* NASA. Langley Research Center, Magnetic Suspension Technology Workshop 1993 p 19-38 (For primary document see N93-27554 10-18)
Avail: CASI HC A03/MF A03

Magnetic bearings are just beginning to be flown in spacecraft systems, but their development spans more than 50 years. The promise of completely noncontacting, unlubricated rotating systems operating at speeds substantially beyond the range of conventional bearings, and with no wear and virtually no vibration, has provided the incentive to develop magnetic bearing technology for many diverse applications. Earnshaw theorized in 1842 that stable magnetic suspension is not possible in all three spatial directions unless the magnetic field is actively controlled. Since that time, researchers have attempted to successfully support spinning rotors in a stable manner. Development of magnetic suspension systems over the past fifty years has included progress on both passive (permanent magnet) and active (electromagnet) systems. The improvements in bearing load capacity, stiffness, and damping characteristics are traced. The trends in rotor size, rotational kinetic energy, and improvements in active control systems capabilities are also reviewed. Implications of superconductivity on suspension system design and performance are discussed.
Author (revised)

N93-27557*# Magnetic Bearings, Inc., Radford, VA.
MAGNETIC BEARING TURBOMACHINERY CASE HISTORIES AND APPLICATIONS FOR SPACE RELATED EQUIPMENT **c37**
David A. Weise *In* NASA. Langley Research Center, Magnetic Suspension Technology Workshop 1993 p 41-48 (For primary document see N93-27554 10-18)
Avail: CASI HC A02/MF A03

The concept of magnetic levitation is not a new one and can be easily traced back to the 1800's. It is only recently, however, that the congruous technologies of electronic control systems, power electronics, and magnetic materials have begun to merge to make the magnetic suspension device a viable product. A brief overview of an active magnetic bearing technology is provided. Case histories of various turbomachinery in North America presently operating on magnetic bearings are reviewed. Finally, projections are made as to the space related machinery that may be benefited by incorporating magnetic bearings into the equipment design.
Author (revised)

N93-27558*# Virginia Univ., Charlottesville. Dept. of Electrical Engineering.
DIGITAL CONTROL OF MAGNETIC BEARINGS SUPPORTING A MULTIMASS FLEXIBLE ROTOR **c37**
F. J. Keith, R. D. Williams, P. E. Allaire, and R. M. Schafer (Tellabs Research Lab., Mishawaka, IN.) *In* NASA. Langley Research Center, Magnetic Suspension Technology Workshop 1993 p 53-71 (For primary document see N93-27554 10-18)
Avail: CASI HC A03/MF A03

The characteristics of magnetic bearings used to support a three mass flexible rotor operated at speeds up to 14,000 RPM are discussed. The magnetic components of the bearing are of a type reported in the literature previously, but the earlier analog controls were replaced by digital ones. Analog-to-digital and digital-to-analog converters and digital control software were installed in an AT&T PC. This PC-based digital controller was used to operate one of the magnetic bearings on the test rig. Basic

proportional-derivative control was applied to the bearings, and the bearing stiffness and damping characteristics were evaluated. Particular attention is paid to the frequency dependent behavior of the stiffness and damping properties, and comparisons are made between the actual controllers and ideal proportional-derivative control. Author (revised)

N93-27559*# Stanford Univ., CA. Dept. of Mechanical Engineering.
SIX DEGREES OF FREEDOM VIBRATION ISOLATION USING ELECTROMAGNETIC SUSPENSION **c39**
Sang-il Lee, Daniel B. DeBra, Peter F. Michelson, Robert C. Taber, and John C. Price *In* NASA. Langley Research Center, Magnetic Suspension Technology Workshop 1993 p 75-84 (For primary document see N93-27554 10-18)
(Grants NSF PHY-85-13525; NSF PHY-85-15856)
Avail: CASI HC A02/MF A03

Experimental data are presented for modeling an electromagnet. Control laws are considered with and without flux feedback and with position and orientation information of the suspended body. Base motion and sensor noise are the principal disturbances. Proper selection of the geometrical operating point minimizes the passive coupling above the bandwidth of the control and filtering can attenuate the high frequency content of sensor noise. Six electromagnets are arranged in a configuration which optimizes the load support and provides control over all six degrees of freedom of the suspended body. The design is based on experimental data generated with a specially designed test facility. Application for suspension of a gravity wave antenna is discussed. Author

N93-27560*# Cornell Univ., Ithaca, NY. Sibley School of Mechanical and Aerospace Engineering.
A CONSTITUTIVE MODEL FOR THE FORCES OF A MAGNETIC BEARING INCLUDING EDDY CURRENTS **c37**
D. L. Taylor and K. V. Hebbale *In* NASA. Langley Research Center, Magnetic Suspension Technology Workshop 1993 p 87-99 Sponsored in part by ONR (For primary document see N93-27554 10-18)
(Contract N00014-80-C-0618)
Avail: CASI HC A03/MF A03

A multiple magnet bearing can be developed from N individual electromagnets. The constitutive relationships for a single magnet in such a bearing is presented. Analytical expressions are developed for a magnet with poles arranged circumferencially. Maxwell's field equations are used so the model easily includes the effects of induced eddy currents due to the rotation of the journal. Eddy currents must be included in any dynamic model because they are the only speed dependent parameter and may lead to a critical speed for the bearing. The model is applicable to bearings using attraction or repulsion. Author

N93-27561*# Mechanical Technology, Inc., Latham, NY. Dept. of Advanced Technology.
MAGNETIC SUSPENSION CHARACTERISTICS OF ELECTROMAGNETIC ACTUATORS **c37**
Dantam K. Rao, J. Dill, and E. Zorzi *In* NASA. Langley Research Center, Magnetic Suspension Technology Workshop 1993 p 105-117 (For primary document see N93-27554 10-18)
Avail: CASI HC A03/MF A03

Electromagnetic actuators that use a current-carrying coil (which is placed in a magnetic field) to generate mechanical force are conceptually attractive components for active control of rotating shafts. In one concept that is being tested in the laboratory, the control forces from such actuators are applied on the flexibly supported bearing housings of the rotor. Development of this concept into a practical reality requires a clear and thorough understanding of the role of electromechanical parameters of these actuators in delivering the right amount of control force at the right phase into the rotor. The electromechanical parameters of the actuators investigated are the mass of the armature, stiffness of its suspension, electrical resistance, and inductance of the coils. Improper selection of these parameters can result in degradation in their performance, leading to mistuning between the actuator and the rotor. Through a simple analysis, it is shown that use of such mistuned actuators could result in sharp fluctuations in the phase of the control force delivered into the rotor around the critical speeds. These sharp fluctuations in phase, called 'Phase Glitches', are undesirable. Hence, future designs of controllers should take into account the undesirable mistuning effects between the actuator and the rotor caused by the phase glitches. Author (revised)

N93-27562*# Massachusetts Inst. of Tech., Cambridge.
DESIGN CONSIDERATIONS FOR ULTRA-PRECISION MAGNETIC BEARING SUPPORTED SLIDES **c37**
Alexander H. Slocum and David B. Eisenhaure (SatCon Technology Corp., Cambridge, MA.) *In* NASA. Langley Research Center, Magnetic Suspension Technology Workshop 1993 p 121-138 (For primary document see N93-27554 10-18)
Avail: CASI HC A03/MF A03

Development plans for a prototype servocontrolled machine with 1 angstrom resolution of linear motion and 50 mm range of travel are described. Two such devices could then be combined to produce a two dimensional machine for probing large planar objects with atomic resolution, the Angstrom Resolution Measuring Machine (ARMM). Author (revised)

N93-27563*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
A MAGNETIC ISOLATION AND POINTING SYSTEM FOR THE ASTROMETRIC TELESCOPE FACILITY **c37**
Marcie Smith, William Hibble (Honeywell, Inc., Glendale, AZ.), and Patrick J. Wolke (Honeywell, Inc., Glendale, AZ.) *In* NASA. Langley Research Center, Magnetic Suspension Technology Workshop 1993 p 141-160 (For primary document see N93-27554 10-18)
(Contract NAS2-12525)
Avail: CASI HC A03/MF A03

The astrometric telescope facility (ATF), a 20-meter telescope designed for long-term detection and observation of planetary systems outside of the solar system, is scheduled to be a major user of the Space Station's payload pointing system (PPS) capabilities. However, because the ATF has such a stringent pointing stability specification (as low as 0.01 arcsec error over the frequency range from 5 to 200 hertz) and requires +/- 180-degree roll rotation around the telescope's line of sight, the ATF's utilization of the PPS requires the addition of a mechanism or mechanisms to enhance the basic PPS capabilities. The results of a study conducted to investigate the ATF pointing performance achievable by the addition of a magnetic isolation and pointing (MIPS) system between the PPS upper gimbal and the ATF, and separately, by the addition of a passive isolation system between the Space Station and the PPS base are presented. In addition, the study produced requirements on magnetic force and gap motion as a function of the level of Space Station disturbance. These results were used to support the definition of a candidate MIPS. Pointing performance results from the study indicate that a MIPS can meet the ATF pointing requirements in the presence of a PPS base transitional acceleration of up to 0.018g, with reasonable restrictions placed on the isolation and pointing bandwidths. By contrast, the passive base isolator system must have an unrealistically low isolation bandwidth on all axes (less than 0.1 hertz) to meet ATF pointing requirements. The candidate MIPS is based on an assumed base translational disturbance of 0.01g. The system fits within the available annular region between the PPS and ATF while meeting power and weight limitations and providing the required payload roll motion. Payload data and power services are provided by noncontacting transfer devices. Author

N93-27564*# Aura Systems, Inc., Los Angeles, CA.
MAGNETIC GIMBAL PROOF-OF-CONCEPT HARDWARE PERFORMANCE RESULTS **c39**
Keith O. Stuart *In* NASA. Langley Research Center, Magnetic Suspension Technology Workshop 1993 p 163-174 (For primary document see N93-27554 10-18)
Avail: CASI HC A03/MF A03

The Magnetic Gimbal Proof-of-Concept Hardware activities, accomplishments, and test results are discussed. The Magnetic Gimbal Fabrication and Test (MGFT) program addressed the feasibility of using a magnetic gimbal to isolate an Electro-Optical (EO) sensor from the severe angular vibrations induced during the firing of divert and attitude control system (ACS) thrusters during space flight. The MGFT effort was performed in parallel with the fabrication and testing of a mechanically gimballed, flex pivot based isolation system by the Hughes Aircraft Missile Systems Group. Both servo systems supported identical EO sensor assembly mockups to facilitate direct comparison of performance. The results obtained from the

MGFT effort indicate that the magnetic gimbal exhibits the ability to provide significant performance advantages over alternative mechanically gimballed techniques. Author (revised)

N93-27565*# Bridgeport Univ., CT.
AN ELECTROMAGNETICALLY LEVITATED TWO-AXIS GIMBALESS POINTING MECHANISM **c37**
Gerald T. Volpe *In* NASA. Langley Research Center, Magnetic Suspension Technology Workshop 1993 p 177-180 (For primary document see N93-27554 10-18)
Avail: CASI HC A01/MF A03

A brief description for a proposed new pointing mechanism which requires no mechanical gimbals, is virtually friction free, and is vibration isolated from a ground support system or vehicle is presented. The device uses electromagnetic forces for support levitation and pointing, both being accomplished from a ground reference thereby leaving the payload virtually free from a remotely located command center. Solid pointing angles of almost 2(pi) steradians are achievable, limited only by structural interference. A third degree-of-freedom tilt axis can be added at will, but will not be elaborated. Although the system is primarily intended for space vehicles in a micro-gravity environment, earth-ground support is possible with superconducting electromagnets. Author (revised)

N93-27566*# Aura Systems, Inc., Los Angeles, CA.
MULTIPLE DEGREE-OF-FREEDOM FORCE AND MOMENT MEASUREMENT FOR STATIC PROPULSION TESTING USING MAGNETIC SUSPENSION TECHNOLOGY **c14**
Keith Stuart and Blake Bartosh *In* NASA. Langley Research Center, Magnetic Suspension Technology Workshop 1993 p 183-196 (For primary document see N93-27554 10-18)
Avail: CASI HC A03/MF A03

Innovative Information Systems (IIS), Inc. is in the process of designing and fabricating a high bandwidth force and moment measuring device (i.e. the Magnetic Thruster Test Stand). This device will use active magnetic suspension to allow direct measurements of the forces and torques generated by the rocket engines of the missile under test. The principle of operation of the Magnetic Thruster Test Stand (MTTS) is based on the ability to perform very precise, high bandwidth force and position measurements on an object suspended in a magnetic field. This ability exists due to the fact that the digital servo control mechanism that performs the magnetic suspension uses high bandwidth (10 kHz) position data (via an eddy-current proximity sensor) to determine the amount of force required to maintain stable suspension at a particular point. This force is converted into required electromagnet coil current, which is then output to a current amplifier driving the coils. A discussion of how the coil current and magnetic gap distance (the distance between the electromagnet and the object being suspended) is used to determine the forces being applied from the suspended assembly is presented. Author (revised)

N93-27567*# Virginia Univ., Charlottesville. Dept. of Mechanical and Aerospace Engineering.
DESIGN AND TEST OF A MAGNETIC THRUST BEARING **c37**
P. E. Allaire, A. Mikula (Kingsbury, Inc., Philadelphia, PA.), B. Banerjee, D. W. Lewis, and J. Imlach *In* NASA. Langley Research Center, Magnetic Suspension Technology Workshop 1993 p 201-219 (For primary document see N93-27554 10-18)
Avail: CASI HC A03/MF A03

A magnetic thrust bearing can be employed to take thrust loads in rotating machinery. The design and construction of a prototype magnetic thrust bearing for a high load per weight application is described. The theory for the bearing is developed. Fixtures were designed and the bearing was tested for load capacity using a universal testing machine. Various shims were employed to have known gap thicknesses. A comparison of the theory and measured results is presented. Author (revised)

N93-27568*# Mechanical Technology, Inc., Latham, NY.
A CONVENTIONAL POINT OF VIEW ON ACTIVE MAGNETIC BEARINGS **c37**
H. Ming Chen and Jim Dill *In* NASA. Langley Research Center, Magnetic Suspension Technology Workshop 1993 p 223-234 (For primary document see N93-27554 10-18)
Avail: CASI HC A03/MF A03

Active magnetic bearings used in rotating machinery should be designed as locally controlled, independent devices similar to other types of bearings. The functions of control electronics and power amplifiers can be simply and explicitly related to general bearing properties such as load capacity, stiffness, and damping. The dynamics of a rotor and its supporting active magnetic bearings are analyzed in a modified conventional method with an extended state vector containing the bearing state variables. Author (revised)

N93-27569*# SatCon Technology Corp., Cambridge, MA.
MAGNETIC BEARINGS FOR A HIGH-PERFORMANCE OPTICAL DISK BUFFER **c37**
Richard Hockney and Timothy Hawkey *In* NASA. Langley Research Center, Magnetic Suspension Technology Workshop 1993 p 237-250 (For primary document see N93-27554 10-18)
(Contract NAS5-30058)
Avail: CASI HC A03/MF A03

An optical disk buffer concept can provide gigabit-per-second data rates and terabit capacity through the use of arrays of solid state lasers applied to a stack of erasable/reusable optical disks. The RCA optical disk buffer has evoked interest by NASA for space applications. The porous graphite air bearings in the rotary spindle as well as those used in the linear translation of the read/write head would be replaced by magnetic bearings or mechanical (ball or roller) bearings. Based upon past experience, roller or ball bearings for the translation stages are not feasible. Unsatisfactory, although limited experience exists with ball bearing spindles also. Magnetic bearings, however, appear ideally suited for both applications. The use of magnetic bearings is advantageous in the optical disk buffer because of the absence of physical contact between the rotating and stationary members. This frictionless operation leads to extended life and reduced drag. The manufacturing tolerances that are required to fabricate magnetic bearings would also be relaxed from those required for precision ball and gas bearings. Since magnetic bearings require no lubricant, they are inherently compatible with a space (vacuum) environment. Magnetic bearings also allow the dynamics of the rotor/bearing system to be altered through the use of active control. This provides the potential for reduced vibration, extended regions of stable operation, and more precise control of position. Author

N93-27570*# Virginia Polytechnic Inst. and State Univ., Blacksburg.
ACTIVE MAGNETIC BEARINGS APPLIED TO INDUSTRIAL COMPRESSORS **c37**
R. G. Kirk, J. F. Hustak (Dresser Industries, Inc., Olean, NY.), and K. A. Schoeneck (Dresser Industries, Inc., Olean, NY.) *In* NASA. Langley Research Center, Magnetic Suspension Technology Workshop 1993 p 253-269 (For primary document see N93-27554 10-18)
Avail: CASI HC A03/MF A03

The design and shop test results are given for a high-speed eight-stage centrifugal compressor supported by active magnetic bearings. A brief summary of the basic operation of active magnetic bearings and the required rotor dynamics analysis are presented with specific attention given to design considerations for optimum rotor stability. The concerns for retrofits of magnetic bearings in existing machinery are discussed with supporting analysis of a four-stage centrifugal compressor. The current status of industrial machinery in North America using this new support system is presented and recommendations are given on design and analysis requirements for successful machinery operation of either retrofit or new design turbomachinery. Author

N93-27571*# Virginia Univ., Charlottesville. Dept. of Mechanical and Aerospace Engineering.
PRACTICAL LIMITS TO THE PERFORMANCE OF MAGNETIC BEARINGS: PEAK FORCE, SLEW RATE, AND DISPLACEMENT SENSITIVITY **c37**
E. Maslen, P. Hermann (Sundstrand Advanced Technology Group, Rockford, IL.), M. Scott, and R. R. Humphris *In* NASA. Langley Research Center, Magnetic Suspension Technology Workshop 1993 p 273-286 (For primary document see N93-27554 10-18)
Avail: CASI HC A03/MF A03

Magnetic bearings are subject to performance limits which are quite different from those of conventional bearings. These are due in part to the inherent nonlinearity of the device and in part to its electrical nature.

Three important nonideal behaviors are presented: peak force capacity, force slew rate limitation, and sensitivity to rotor motion at large displacements. The problem of identifying the dynamic requirements of a magnetic bearing when used to support a known structure subject to known loads is discussed in the context of these limitations. Several simple design tools result from this investigation. Author

N93-27572*# SatCon Technology Corp., Cambridge, MA.
ADVANCED ACTUATORS FOR THE CONTROL OF LARGE SPACE STRUCTURES
James Downer, Richard Hockney, Bruce Johnson, and Kathleen Misovec *In* NASA. Langley Research Center, Magnetic Suspension Technology Workshop 1993 p 289-314 (For primary document see N93-27554 10-18)
(Contract NAS1-18426)
Avail: CASI HC A03/MF A03

The objective of this research was to develop advanced six-degree-of-freedom actuators employing magnetic suspensions suitable for the control of structural vibrations in large space structures. The advanced actuators consist of a magnetically suspended mass that has three-degrees-of-freedom in both translation and rotation. The most promising of these actuators featured a rotating suspended mass providing structural control torques in a manner similar to a control moment gyro (CMG). These actuators employ large-angle-magnetic suspensions that allow gimballing of the suspended mass without mechanical gimbals. Design definitions and sizing algorithms for these CMG type as well as angular reaction mass actuators based on multi-degree-of-freedom magnetic suspensions were developed. The performance of these actuators was analytically compared with conventional reaction mass actuators for a simple space structure model. Author

N93-27573*# Texas A&M Univ., College Station.
AN AC-ELECTROMAGNETIC BEARING FOR FLYWHEEL ENERGY STORAGE IN SPACE **c37**
Jorgen L. Nikolajsen *In* NASA. Langley Research Center, Magnetic Suspension Technology Workshop 1993 p 317-323 (For primary document see N93-27554 10-18)
Avail: CASI HC A02/MF A03

A repulsive type AC-electromagnetic bearing was developed and tested. It was conceived on the basis of the so-called Magnetic River suspension for high-speed trains. The appearance of the bearing is similar to the traditional DC-type electromagnetic bearing but the operating principle is different. The magnets are fed with alternating current instead of direct current and the rotor is fitted with a conducting sleeve (e.g. aluminum) instead of a ferromagnetic sleeve. The repulsion is due to induction of eddy-currents in the conducting sleeve. The bearing is inherently stable and requires no feedback control. It provides support in five degrees of freedom such that a short rotor may be fully supported by a single bearing. These capabilities were demonstrated experimentally. On the down side, the load carrying capacity and the damping obtained so far were quite low compared to the DC-type bearing. Also, significant heating of the conducting sleeve was experienced. The AC-bearing is essentially a modified induction motor and there are strong indications that it can be run both as a motor and as a generator with no commutator requirements. It is therefore considered to be a good candidate for support of energy storage flywheels in space. Author (revised)

N93-27574*# Technical Planning, Inc., Bethesda, MD.
HIGH EFFICIENCY MAGNETIC BEARINGS **c37**
Philip A. Studer, Chaitanya P. Jayaraman (Maryland Univ., College Park.), Davinder K. Anand (Maryland Univ., College Park.), and James A. Kirk (Maryland Univ., College Park.) *In* NASA. Langley Research Center, Magnetic Suspension Technology Workshop 1993 p 327-337 (For primary document see N93-27554 10-18)
(Grant NAG5-396)
Avail: CASI HC A03/MF A03

Research activities concerning high efficiency permanent magnet plus electromagnet (PM/EM) pancake magnetic bearings at the University of Maryland are reported. A description of the construction and working of the magnetic bearing is provided. Next, parameters needed to describe the bearing are explained. Then, methods developed for the design and testing of magnetic bearings are summarized. Finally, a new magnetic bearing which allows active torque control in the off axes directions is discussed. Author (revised)

N93-27575*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
DEVELOPMENT OF SUPERCONDUCTING YBa2Cu3O(x) WIRES WITH LOW RESISTANCE ELECTRICAL CONTACTS **c33**
A. M. Buoncristiani, C. E. Byvik, R. Caton (Christopher Newport Coll., Newport News, VA.), R. Selim (Christopher Newport Coll., Newport News, VA.), B. I. Lee (Clemson Univ., SC.), V. Modi (Clemson Univ., SC.), M. Sherrill (Clemson Univ., SC.), H. D. Leigh (Clemson Univ., SC.), C. C. Fain (Clemson Univ., SC.), and G. Lewis (Clemson Univ., SC.) et al *In its* Magnetic Suspension Technology Workshop 1993 p 343-357 (For primary document see N93-27554 10-18)
(Grants NAG1-796; NAG1-820)
Avail: CASI HC A03/MF A03

Materials exhibiting superconductivity above liquid nitrogen temperatures (77 K) will enable new applications of this phenomena. One of the first commercial applications of this technology will be superconducting magnets for medical imaging. However, a large number of aerospace applications of the high temperature superconducting materials have also been identified. These include magnetic suspension and balance of models in wind tunnels and resistanceless leads to anemometers. The development of superconducting wires fabricated from the ceramic materials is critical for these applications. The progress in application of a patented fiber process developed by Clemson University for the fabrication of superconducting wires is reviewed. The effect of particle size and heat treatment on the quality of materials is discussed. Recent advances made at Christopher Newport College in the development of micro-ohm resistance electrical contacts which are capable of carrying the highest reported direct current to this material is presented. Author (revised)

N93-27576*# SatCon Technology Corp., Cambridge, MA.
THE ROLE OF SUPERCONDUCTIVITY IN MAGNETIC BEARINGS FOR HIGH-LOAD APPLICATIONS **c37**
James Downer and David Eisenhaure *In* NASA. Langley Research Center, Magnetic Suspension Technology Workshop 1993 p 361-372 (For primary document see N93-27554 10-18)
Avail: CASI HC A03/MF A03

Slewing of large payloads will require control torque and angular momentum storage capacities that are large in comparison to the capabilities of available control moment gyros (CMG's). SatCon Technology Corporation is currently designing a CMG which may be employed as a slew actuator for large spacecraft or other payloads. The slew actuator employs a type of magnetic bearing which may be used in high load applications. The magnetic bearing is also used to fully gimbal the suspended rotor of the slew actuator. The use of magnetic bearings in angular momentum exchange actuators has the primary advantage that physical contact between the rotor and stator is eliminated. This leads to greatly extended life, increased reliability, and reduced vibrations. Several actuators operating on magnetic bearings have been demonstrated in previous research efforts. These were sized for use in small satellites. For conventional magnetic bearings, which employ magnetic cores, high torsional loading may require that the magnetic structure be excessively massive. An alternative magnetic bearing design which employs a superconducting coil and eliminates conventional magnetic structures is discussed. The baseline approach is to replace the field coil of a conventional magnetic bearing with the superconducting coil.
Author (revised)

N93-27577*# SatCon Technology Corp., Cambridge, MA.
SUPERCONDUCTING LINEAR ACTUATOR
Bruce Johnson and Richard Hockney *In* NASA. Langley Research Center, Magnetic Suspension Technology Workshop 1993 p 375-386 (For primary document see N93-27554 10-18)
Avail: CASI HC A03/MF A03

Special actuators are needed to control the orientation of large structures in space-based precision pointing systems. Electromagnetic actuators that presently exist are too large in size and their bandwidth is too low. Hydraulic fluid actuation also presents problems for many space-based applications. Hydraulic oil can escape in space and contaminate the environment around the spacecraft. A research study was performed that selected an

electrically-powered linear actuator that can be used to control the orientation of a large pointed structure. This research surveyed available products, analyzed the capabilities of conventional linear actuators, and designed a first-cut candidate superconducting linear actuator. The study first examined theoretical capabilities of electrical actuators and determined their problems with respect to the application and then determined if any presently available actuators or any modifications to available actuator designs would meet the required performance. The best actuator was then selected based on available design, modified design, or new design for this application. The last task was to proceed with a conceptual design. No commercially-available linear actuator or modification capable of meeting the specifications was found. A conventional moving-coil dc linear actuator would meet the specification, but the back-iron for this actuator would weigh approximately 12,000 lbs. A superconducting field coil, however, eliminates the need for back iron, resulting in an actuator weight of approximately 1000 lbs.

Author

N93-27578*# Massachusetts Inst. of Tech., Cambridge. Electromagnetic and Electronic Systems Lab.

PERFORMANCE OF CERAMIC SUPERCONDUCTORS IN MAGNETIC BEARINGS **c37**

James L. Kirtley, Jr. and James R. Downer (SatCon Technology Corp., Cambridge, MA.) *In* NASA. Langley Research Center, Magnetic Suspension Technology Workshop 1993 p 389-404 Sponsored in part by NSF (For primary document see N93-27554 10-18)

Avail: CASI HC A03/MF A03

Magnetic bearings are large-scale applications of magnet technology, quite similar in certain ways to synchronous machinery. They require substantial flux density over relatively large volumes of space. Large flux density is required to have satisfactory force density. Satisfactory dynamic response requires that magnetic circuit permeances not be too large, implying large air gaps. Superconductors, which offer large magnetomotive forces and high flux density in low permeance circuits, appear to be desirable in these situations. Flux densities substantially in excess of those possible with iron can be produced, and no ferromagnetic material is required. Thus the inductance of active coils can be made low, indicating good dynamic response of the bearing system. The principal difficulty in using superconductors is, of course, the deep cryogenic temperatures at which they must operate. Because of the difficulties in working with liquid helium, the possibility of superconductors which can be operated in liquid nitrogen is thought to extend the number and range of applications of superconductivity. Critical temperatures of about 98 degrees Kelvin were demonstrated in a class of materials which are, in fact, ceramics. Quite a bit of public attention was attracted to these new materials. There is a difficulty with the ceramic superconducting materials which were developed to date. Current densities sufficient for use in large-scale applications have not been demonstrated. In order to be useful, superconductors must be capable of carrying substantial currents in the presence of large magnetic fields. The possible use of ceramic superconductors in magnetic bearings is investigated and discussed and requirements that must be achieved by superconductors operating at liquid nitrogen temperatures to make their use comparable with niobium-titanium superconductors operating at liquid helium temperatures are identified. Author (revised)

N93-27579*# National Aeronautics and Space Administration, Washington, DC.

ADVISORY COMMITTEE ON THE REDESIGN OF THE SPACE STATION Final Report to the President

10 Jun. 1993 84 p

(NASA-TM-108760; NAS 1.15:108760) Avail: CASI HC A05/MF A01

The Space Station Program was initiated in 1984 to provide for permanent human presence in an orbiting laboratory. This program evolved into Space Station Freedom, later identified as a component to facilitate a return of astronauts to the Moon, followed by the exploration of Mars. In March 1993 the Clinton Administration directed NASA to undertake an intense effort to redesign the space station at a substantial cost savings relative to Space Station Freedom. The Advisory Committee on the Redesign of the Space Station was established in March 1993 to provide independent assessment of the advantages and disadvantages of the redesign options. The results of the Committee's work is described. Discussion describes the mission that the Administration has articulated for the Space Station Program and the scientific and technical characteristics that a redesigned station must possess to fulfill those objectives. A description of recommended management, operations, and acquisition strategies for the redesigned program is provided. The Committee's assessment of the redesign options against five criteria are presented. The five criteria are technical capabilities, research capabilities, schedule, cost, and risk. A discussion of general mission risk is included. Derived from text

N93-27650# Aerospace Corp., El Segundo, CA. Engineering and Technology Group.

MINIMIZING ERROR IN PREDICTING THE RELIABILITY OF ON-BOARD SATELLITE SYSTEMS Final Report, Jun. 1991 - Jun. 1992

D. A. Lee, Jr. and G. C. Gilley Oct. 1992 64 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (Contract F04701-88-C-0089)

(AD-A262212; TR-93(3411)-2; SMC-TR-93-13) Avail: CASI HC A04

The reliability prediction process for large, closed (i.e., non-repairable) fault-tolerant, on-board satellite systems is addressed, along with techniques for reduction of error in prediction. Three major error sources are discussed, only one of which can be effectively minimized by modelers. Specific error sources in model construction are identified. It is presented that, although errors exist in the reliability prediction process, complete accuracy is not required for effective use of the predictions in the design process. A set of three tools (CARE III Bavu 84a, Bavu 84b), (HARP HARP 89), and CRAFTS(CRAF 88) are used to model an example on-board system design to illustrate minimization of errors. Guidelines for selecting the proper reliability tools are also given. DTIC

N93-27686# Arnold Engineering Development Center, Arnold AFS, TN.

EFFECTS OF SPACECRAFT MATERIALS OUTGASSING PRODUCTS ON CRYOGENIC SURFACES Final Report, Feb. 1989 - Jul. 1992

W. T. Bertrand and B. E. Wood Mar. 1993 61 p

(AD-A262671; AEDC-TR-92-18) Avail: CASI HC A04/MF A01

Optical property measurements of condensed contaminant films on cryogenically cooled substrates were reported in AEDC-TR-87-8 and AEDC-TR-89-2. Measurements for five additional materials and three material mixtures are presented in this report. Infrared spectral transmittance measurements were made for thin films of contaminant deposited on a 77 K germanium window under vacuum conditions. Material temperatures were controlled at 125 deg C to provide the outgassing source. The objective of this report is to present the refractive and absorptive indices of the condensed outgassing products of satellite materials which have been determined from the experimental measurements of infrared transmittance, and to describe an effort to combine optical property data from two materials to provide values that can be used to calculate the surface effects for contaminant mixtures. DTIC

N93-27704*# National Aeronautics and Space Administration, Washington, DC.

TECHNOLOGY FOR SPACE STATION EVOLUTION. VOLUME 2: DATA MANAGEMENT SYSTEM/ENVIRONMENTAL CONTROL AND LIFE SUPPORT SYSTEMS

1990 544 p Workshop held in Dallas, TX, 16-19 Jan. 1990 Original contains color illustrations

(NASA-TM-108725; NAS 1.15:108725) Avail: CASI HC A23/MF A04; 1 functional color page

NASA's Office of Aeronautics and Space Technology conducted a workshop on technology for space station evolution 16-19 Jan. 1990. The purpose of the workshop was to collect and clarify Space Station Freedom technology requirements for evolution and to describe technologies that can potentially fill those requirements. These proceedings are organized into an Executive Summary and Overview and five volumes containing the Technology Discipline Presentations. Volume 2 consists of the technology discipline sections for the Data Management System and the Environmental Control and Life Support Systems. For each technology discipline, there is a Level 3 subsystem description, along with the invited papers. For individual titles, see N93-27705 through N93-27725.

N93-27705*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

TECHNOLOGY FOR SPACE STATION EVOLUTION: THE DATA MANAGEMENT SYSTEM **c82**

L. Abbott *In* NASA, Washington, Technology for Space Station Evolution.

Volume 2: Data Management System/Environmental Control and Life Support Systems 1990 p 5-35 (For primary document see N93-27704 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

Viewgraphs on the data management system (DMS) for the space station evolution are presented. Topics covered include DMS architecture and implementation approach; and an overview of the runtime object database. CASI

N93-27706*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
SPACE STATION FREEDOM SOFTWARE SUPPORT ENVIRONMENT c61

Susan J. Voigt *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems 1990 p 39-73 (For primary document see N93-27704 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

Viewgraphs on the Space Station Freedom Software Support Environment are presented. After a brief overview of the SSE, the implementation approach and the current and planned functionality are described. The implications and future potential of this common environment for software development and sustaining engineering are also discussed. Derived from text

N93-27707*# Draper (Charles Stark) Lab., Inc., Cambridge, MA.
VALIDATED FAULT TOLERANT ARCHITECTURES FOR SPACE STATION c82

Jaynarayan H. Lala *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems 1990 p 75-101 (For primary document see N93-27704 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

Viewgraphs on validated fault tolerant architectures for space station are presented. Topics covered include: fault tolerance approach; advanced information processing system (AIPS); and fault tolerant parallel processor (FTPP). CASI

N93-27708*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A FAULT-TOLERANT RISC MICROPROCESSOR FOR SPACECRAFT APPLICATIONS c60

Constantin Timoc (Spaceborn, Inc., La Canada, CA.) and Harry Benz *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems 1990 p 103-110 (For primary document see N93-27704 10-18)
Avail: CASI HC A02/MF A04; 1 functional color page

Viewgraphs on a fault-tolerant RISC microprocessor for spacecraft applications are presented. Topics covered include: reduced instruction set computer; fault tolerant registers; fault tolerant ALU; and double rail CMOS logic. CASI

N93-27709*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
HIGH RATE SCIENCE DATA HANDLING c82

Richard C. Masline *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems 1990 p 111-128 (For primary document see N93-27704 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

Viewgraphs on high rate science data handling are presented. Topics covered include: science needs versus technology; technology assessment; conceptual architecture; and direct downlink concept. CASI

N93-27710*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
OPTICAL DISK TECHNOLOGY SPACEFLIGHT OPTICAL DISK RECORDER (SODR) c82

Pamela Rinsland *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems 1990 p 129-139 (For primary document see N93-27704 10-18)
Avail: CASI HC A02/MF A04; 1 functional color page

Viewgraphs on optical disk technology - spaceflight optical disk recorder (SODR) are presented. Topics covered include: SODR; key technologies; disk drive; and system concept. CASI

N93-27711*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
ELECTRONIC NEURAL NETWORKS c63

Anil Thakoor *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems 1990 p 141-166 (For primary document see N93-27704 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

Viewgraphs on electronic neural networks for space station are presented. Topics covered include: electronic neural networks; electronic implementations; VLSI/thin film hybrid hardware for neurocomputing; computations with analog parallel processing; features of neuroprocessors; applications of neuroprocessors; neural network hardware for terrain trafficability determination; a dedicated processor for path planning; neural network system interface; neural network for robotic control; error backpropagation algorithm for learning; resource allocation matrix; global optimization neuroprocessor; and electrically programmable read only thin-film synaptic array. CASI

N93-27712*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
SPACE STATION DISPLAYS AND CONTROLS TECHNOLOGY EVOLUTION

Greg C. Blackburn *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems 1990 p 167-175 (For primary document see N93-27704 10-18)
Avail: CASI HC A02/MF A04; 1 functional color page

Viewgraphs on space station displays and controls technology evolution are presented. Topics covered include: a historical perspective; major development objectives; current development activities; key technology areas; and technology evolution issues. CASI

N93-27713*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EMBEDDED MULTIPROCESSOR TECHNOLOGY FOR VHSIC INSERTION c60

Paul J. Hayes *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems 1990 p 177-196 (For primary document see N93-27704 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

Viewgraphs on embedded multiprocessor technology for VHSIC insertion are presented. The objective was to develop multiprocessor system technology providing user-selectable fault tolerance, increased throughput, and ease of application representation for concurrent operation. The approach was to develop graph management mapping theory for proper performance, model multiprocessor performance, and demonstrate performance in selected hardware systems. CASI

N93-27714*# National Inst. of Standards and Technology, Gaithersburg, MD.
DATA MANAGEMENT STANDARDS IN COMPUTER-AIDED ACQUISITION AND LOGISTIC SUPPORT (CALS) c82

David K. Jefferson *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems 1990 p 197-225 (For primary document see N93-27704 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

Viewgraphs and discussion on data management standards in computer-aided acquisition and logistic support (CALS) are presented. CALS is intended to reduce cost, increase quality, and improve timeliness of weapon system acquisition and support by greatly improving the flow of technical information. The phase 2 standards, industrial environment, are discussed. The information resource dictionary system (IRDS) is described. CASI

N93-27715*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

AUTOMATIC MANAGEMENT OF PARALLEL AND DISTRIBUTED SYSTEM RESOURCES **c62**

Jerry Yan, Tin Fook Ngai (Stanford Univ., CA.), and Stephen F. Lundstrom (Stanford Univ., CA.) *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems 1990 p 227-247 (For primary document see N93-27704 10-18)

Avail: CASI HC A03/MF A04; 1 functional color page

Viewgraphs on automatic management of parallel and distributed system resources are presented. Topics covered include: parallel applications; intelligent management of multiprocessing systems; performance evaluation of parallel architecture; dynamic concurrent programs; compiler-directed system approach; lattice gaseous cellular automata; and sparse matrix Cholesky factorization. CASI

N93-27716*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

ONBOARD SYSTEM HEALTH ASSESSMENT

Tom Barry and Harry Cunningham (Lockheed Engineering and Sciences Co., Houston, TX.) *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems 1990 p 249-283 (For primary document see N93-27704 10-18)

Avail: CASI HC A03/MF A04; 1 functional color page

Viewgraphs and discussion of onboard system health assessment are presented. Success of the space station program will be measured by how well it addresses the basic requirements for (1) maintaining the orbiting Space Station Freedom fully operational for its projected life of thirty years, and (2) the cost-effective execution of the overall space station program. Onboard system health assessment must provide complete and thorough testing capabilities along with effective associated redundancy/fault management. Derived from text

N93-27717*# Stanford Univ., CA. Computer Systems Lab.

AN OVERVIEW OF MCC AND ITS RESEARCH **c60**

Stephen F. Lundstrom *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems 1990 p 285-313 (For primary document see N93-27704 10-18)

Avail: CASI HC A03/MF A04; 1 functional color page

Viewgraphs on Microelectronics and Computer Technology Corporation (MCC) are presented. The MCC is a cooperative enterprise whose mission is to strengthen and sustain America's competitiveness in information technologies. Their objective is excellence in meeting broad industry needs through application-driven research, development, and timely deployment of innovative technology. Research programs include: software technology; VLSI/computer aided design; packaging/interconnect; electronic applications of high temperature superconductors; and advanced computing technology. Derived from text

N93-27718*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

ENVIRONMENTAL CONTROL AND LIFE SUPPORT SYSTEM **c54**

Charles Ray and Alan Adams *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems 1990 p 317-341 (For primary document see N93-27704 10-18)

Avail: CASI HC A03/MF A04; 1 functional color page

Viewgraphs on the Environmental Control and Life Support System (ECLSS) for the space station are presented. The ECLSS is divided into six subsystems: temperature and humidity control (THC), atmosphere control and supply (ACS), atmosphere revitalization (AR), fire detection and suppression (FDS), water recovery management (WRM), and waste management (WM). Topics covered include: ECLSS subsystem functions; ECLSS distributed system; ECLSS functional distribution; CO2 removal; CO2 reduction; oxygen generation; urine processor; and potable water recovery. CASI

N93-27719*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

ENVIRONMENTAL CONTROL AND LIFE SUPPORT SYSTEM EVOLUTION **c54**

Paul Wieland *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems 1990 p 343-365 (For primary document see N93-27704 10-18)

Avail: CASI HC A03/MF A04; 1 functional color page

Viewgraphs on Environmental Control and Life Support System (ECLSS) evolution are presented. The Space Station Freedom ECLSS will have to accommodate the changes to Freedom as it evolves over the design life of 30 years or more. Requirements will change as pressurized modules are added, crew numbers increase, and as the tasks to be performed change. This evolution will result in different demands on the ECLSS and the numbers ECLSS will have to adapt. Technologies other than the baselined ones may be better able to perform the various tasks and technological advances will result in improved life support hardware having better performance, increased reliability, reduced power consumption, weight, and volume, greater autonomy, and fewer resupply requirements. A preliminary study was performed to look at alternative technologies for life support and evaluate them for their integration requirements. Derived from text

N93-27720*# McDonnell-Douglas Space Systems Co., Huntsville, AL.

TECHNOLOGIES FOR ECLSS EVOLUTION **c54**

Bryce L. Diamant *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems 1990 p 367-493 (For primary document see N93-27704 10-18)

(Contract NAS8-36407)

Avail: CASI HC A05/MF A04; 1 functional color page

Viewgraphs and discussion on technologies for Environmental Control and Life Support System (ECLSS) evolution are presented. Topics covered include: atmosphere revitalization including CO2 removal, CO2 reduction, O2 generation, and trace contaminant control; water recovery and management including urine processing, hygiene water processing, and potable water processing; and waste management. ECLSS technology schematics, process diagrams, and fluid interfaces are included. CASI

N93-27721*# Texas A&M Univ., College Station. Space Research Center.

ALTERNATIVE PROCESSES FOR WATER RECLAMATION AND SOLID WASTE PROCESSING IN A PHYSICAL/CHEMICAL BIOREGENERATIVE LIFE SUPPORT SYSTEM **c54**

Tom D. Rogers *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems 1990 p 495-515 (For primary document see N93-27704 10-18)

Avail: CASI HC A03/MF A04; 1 functional color page

Viewgraphs on alternative processes for water reclamation and solid waste processing in a physical/chemical-bioregenerative life support system are presented. The main objective is to focus attention on emerging influences of secondary factors (i.e., waste composition, type and level of chemical contaminants, and effects of microorganisms, primarily bacteria) and to constructively address these issues by discussing approaches which attack them in a direct manner. Derived from text

N93-27722*# Wyle Labs., Inc., Huntsville, AL.

INCREASED FIRE AND TOXIC CONTAMINANT DETECTION RESPONSIBILITY BY USE OF DISTRIBUTED, ASPIRATING SENSORS **c54**

Wallace W. Youngblood *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems 1990 p 517-541 (For primary document see N93-27704 10-18)

Avail: CASI HC A03/MF A04; 1 functional color page

Viewgraphs of increased fire and toxic contaminant detection responsivity by use of distributed, aspirating sensors for space station are presented. Objectives of the concept described are (1) to enhance fire and toxic contaminant detection responsivity in habitable regions of space station; (2) to reduce system weight and complexity through centralized

detector/monitor systems; (3) to increase fire signature information from selected locations in a space station module; and (4) to reduce false alarms. Derived from text

N93-27723*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

THE ECLSS ADVANCED AUTOMATION PROJECT EVOLUTION AND TECHNOLOGY ASSESSMENT **c54**

Brandon S. Dewberry, James R. Carnes (Boeing Co., Huntsville, AL.), Brenda D. Lukefahr (Alabama Univ., Huntsville.), John S. Rogers (Alabama Univ., Huntsville.), Daniel M. Rochowiak (Alabama Univ., Huntsville.), James W. McKee (Alabama Univ., Huntsville.), and Brian L. Benson (Alabama Univ., Huntsville.) *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems 1990 p 543-565 (For primary document see N93-27704 10-18)

Avail: CASI HC A03/MF A04; 1 functional color page

Viewgraphs on Environmental Control and Life Support System (ECLSS) advanced automation project evolution and technology assessment are presented. Topics covered include: the ECLSS advanced automation project; automatic fault diagnosis of ECLSS subsystems descriptions; in-line, real-time chemical and microbial fluid analysis; and object-oriented, distributed chemical and microbial modeling of regenerative environmental control systems description. CASI

N93-27724*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

MARSHALL SPACE FLIGHT CENTER ECLSS TECHNOLOGY ACTIVITIES **c54**

Paul Wieland *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems 1990 p 567-598 (For primary document see N93-27704 10-18)

Avail: CASI HC A03/MF A04; 1 functional color page

Viewgraphs on Environmental Control and Life Support System (ECLSS) technology activities are presented. Topics covered include: analytical development; ECLSS modeling approach; example of water reclamation modeling needs; and hardware development and testing. CASI

N93-27725*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

JSC ECLSS R/T PROGRAM OVERVIEW **c54**

A. F. Behrend *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems 1990 p 599-619 (For primary document see N93-27704 10-18)

Avail: CASI HC A03/MF A04; 1 functional color page

Viewgraphs on Johnson Space Center Environmental Control and Life Support System (ECLSS) research and technology program overview are presented. Topics covered include: advancements in electrochemical CO2 removal; supercritical water waste oxidation; electrooxidation for post-treatment of reclaimed water; and photocatalytic post-treatment of reclaimed water. CASI

N93-27786*# National Aeronautics and Space Administration, Washington, DC.

TECHNOLOGY FOR SPACE STATION EVOLUTION. VOLUME 3: EVA/MANNED SYSTEMS/FLUID MANAGEMENT SYSTEM

1990 327 p Workshop held in Dallas, TX, 16-19 Jan. 1990 Original contains color illustrations

(NASA-TM-108726; NAS 1.15:108726) Avail: CASI HC A15/MF A03; 1 functional color page

NASA's Office of Aeronautics and Space Technology (OAST) conducted a workshop on technology for space station evolution 16-19 Jan. 1990 in Dallas, Texas. The purpose of this workshop was to collect and clarify Space Station Freedom technology requirements for evolution and to describe technologies that can potentially fill those requirements. These proceedings are organized into an Executive Summary and Overview and five volumes containing the Technology Discipline Presentations. Volume 3 consists of the technology discipline sections for Extravehicular Activity/Manned Systems and the Fluid Management System. For each technology discipline, there is a Level 3 subsystem description, along with the papers. For individual titles, see N93-27787 through N93-27802.

N93-27787*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

EXTRAVEHICULAR ACTIVITY SYSTEM **c54**

Michael N. Rouen *In* NASA, Washington, Technology for Space Station Evolution. Volume 3: EVA/Manned Systems/Fluid Management System 1990 p 5-31 (For primary document see N93-27786 10-18)

Avail: CASI HC A03/MF A03; 1 functional color page

Viewgraphs and discussion on the extravehicular activity system for space station evolution are presented. The following topics are addressed: (1) EVAS program status; (2) definition of EVAS baseline; (3) baseline functional requirements; (4) definition of evolutionary EVAS; (5) evolutionary EVAS functional requirements; and (6) technology status. CASI

N93-27788*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

MAN-SYSTEMS DISTRIBUTED SYSTEM FOR SPACE STATION FREEDOM **c54**

J. L. Lewis *In* NASA, Washington, Technology for Space Station Evolution. Volume 3: EVA/Manned Systems/Fluid Management System 1990 p 33-56 (For primary document see N93-27786 10-18)

Avail: CASI HC A03/MF A03; 1 functional color page

Viewgraphs on man-systems distributed system for Space Station Freedom are presented. Topics addressed include: description of man-systems (definition, requirements, scope, subsystems, and topologies); implementation (approach, tools); man-systems interfaces (system to element and system to system); prime/supporting development relationship; selected accomplishments; and technical challenges. CASI

N93-27789*# National Aeronautics and Space Administration, Washington, DC.

EVA/MANNED SYSTEMS **c54**

James P. Jenkins *In its* Technology for Space Station Evolution. Volume 3: EVA/Manned Systems/Fluid Management System 1990 p 59-68 (For primary document see N93-27786 10-18)

Avail: CASI HC A02/MF A03; 1 functional color page

Viewgraphs on extravehicular activity/manned systems are presented. Objectives of crewstation design include (1) development of human-computer interface technology and graphical presentations, including multi-dimensional visual and aural displays; (2) provide a technology base for autonomous vision and other perceptual systems, virtual workstation technology, and computational vision systems; and (3) develop databases and models of human strength, motion, and body positions in microgravity environments. Extravehicular technology is addressed. CASI

N93-27790*# Hamilton Standard, Windsor Locks, CT. Space and Sea Systems.

EVOLUTION OF SPACE STATION EMU PLSS TECHNOLOGY RECOMMENDATIONS **c54**

Richard C. Wilde *In* NASA, Washington, Technology for Space Station Evolution. Volume 3: EVA/Manned Systems/Fluid Management System 1990 p 69-111 (For primary document see N93-27786 10-18)

Avail: CASI HC A03/MF A03; 1 functional color page

Viewgraphs on extravehicular mobility unit (EMU) portable life support system (PLSS) technology recommendations are presented. Topics covered include: oxygen supply storage; oxygen supply regulators; carbon dioxide control; prime movers; crew comfort; heat rejection; power sources; controls; display devices; and sensor technology. CASI

N93-27791*# McDonnell-Douglas Space Systems Co., Huntington Beach, CA.

EVOLVING EVA SYSTEM CAPABILITY FOR THE EVOLVING SPACE STATION FREEDOM REQUIREMENTS **c54**

Howard Slade *In* NASA, Washington, Technology for Space Station Evolution. Volume 3: EVA/Manned Systems/Fluid Management System 1990 p 113-119 (For primary document see N93-27786 10-18)

Avail: CASI HC A02/MF A03; 1 functional color page

Viewgraphs on evolving extravehicular activity (EVA) system capability for the evolving Space Station Freedom requirements are presented. Topics

covered include: pre-scrub 1989 baseline; approach shift resulting from scrub 1989; considerations for alternative selection; EVA supply options; and key technologies for evolution of EVA system life support. CASI

N93-27792*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

EVA AND TELEROBOT INTERACTION **c54**

Kelli F. Willshire *In* NASA, Washington, Technology for Space Station Evolution. Volume 3: EVA/Manned Systems/Fluid Management System 1990 p 121-139 (For primary document see N93-27786 10-18)

Avail: CASI HC A03/MF A03; 1 functional color page

We are about to enter into a new era - that of astronauts working hand in hand with telerobots in space. This has been done to some degree with astronauts and the Space Station Shuttle's Remote Manipulator Arm. However, for the Space Station Freedom, not only will astronauts be working with the RMS type system but also with smaller, more dexterous systems such as the Flight Telerobotic Servicer (FTS). Because EVA time is a premium resource, the most effective use of the astronauts and the telerobot will be required. There may be some tasks for which it is most efficient to have both the EVA astronaut and the telerobot working together. This type of close integration has not occurred before and brings up many issues. Most of these issues are related to technology: communication must be infallible, new control systems and devices may be required, enhanced telerobot safety systems may be necessary. IVA operations may also be affected by the combined EVA telerobot tasks. There is also the issue of how the EVA astronaut and the telerobot work on separate tasks but at the same time. For both situations, research and development of at least some new technology is required; enhanced communication both by voice and data, sophisticated collision detection systems, more responsive controls and displays. These new systems or system enhancements may require knowledge base systems for their operation. Some of the important issues, types of tasks, the FTS capabilities, the technology that is needed to address those issues, and the possible impact on Space Station Freedom are reviewed. Author (revised)

N93-27793*# Lockheed Missiles and Space Co., Sunnyvale, CA. Astronautics Div.

SIMPLIFIED AID FOR CREW RESCUE (SAFR) **c54**

H. Thomas Fisher *In* NASA, Washington, Technology for Space Station Evolution. Volume 3: EVA/Manned Systems/Fluid Management System 1990 p 141-163 (For primary document see N93-27786 10-18)

Avail: CASI HC A03/MF A03; 1 functional color page

Viewgraphs and discussion of a Crew Emergency Rescue System (CERS) are presented. Topics covered include: functional description; operational description; interfaces with other subsystems/elements; simplified aid for crew rescue (SACR) characteristics; potential resource requirements; logistics, repair, and resupply; potential performance improvements; and automation impact. CASI

N93-27794*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

EVOLVING TECHNOLOGIES FOR SPACE STATION FREEDOM COMPUTER-BASED WORKSTATIONS **c54**

Dean G. Jensen and Marianne Rudisill *In* NASA, Washington, Technology for Space Station Evolution. Volume 3: EVA/Manned Systems/Fluid Management System 1990 p 165-179 (For primary document see N93-27786 10-18)

Avail: CASI HC A03/MF A03; 1 functional color page

Viewgraphs on evolving technologies for Space Station Freedom computer-based workstations are presented. The human-computer computer software environment modules are described. The following topics are addressed: command and control workstation concept; cupola workstation concept; Japanese experiment module RMS workstation concept; remote devices controlled from workstations; orbital maneuvering vehicle free flyer; remote manipulator system; Japanese experiment module exposed facility; Japanese experiment module small fine arm; flight telerobotic servicer; human-computer interaction; and workstation/robotics related activities. CASI

N93-27795*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

MAN-SYSTEMS INTEGRATION AND THE MAN-MACHINE INTERFACE **c54**

Joseph P. Hale *In* NASA, Washington, Technology for Space Station Evolution. Volume 3: EVA/Manned Systems/Fluid Management System 1990 p 181-192 (For primary document see N93-27786 10-18)

Avail: CASI HC A03/MF A03; 1 functional color page

Viewgraphs on man-systems integration and the man-machine interface are presented. Man-systems integration applies the systems' approach to the integration of the user and the machine to form an effective, symbiotic Man-Machine System (MMS). A MMS is a combination of one or more human beings and one or more physical components that are integrated through the common purpose of achieving some objective. The human operator interacts with the system through the Man-Machine Interface (MMI). CASI

N93-27796*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

FLUID MANAGEMENT SYSTEM (FMS) FLUID SYSTEMS OVERVIEW

R. S. Baird *In* NASA, Washington, Technology for Space Station Evolution. Volume 3: EVA/Manned Systems/Fluid Management System 1990 p 199-221 (For primary document see N93-27786 10-18)

Avail: CASI HC A03/MF A03; 1 functional color page

Viewgraphs on fluid management system (FMS) fluid systems overview are presented. Topics addressed include: fluid management system description including system requirements (integrated nitrogen system, integrated water system, and integrated waste gas system) and physical description; and fluid management system evolution. CASI

N93-27797*# Boeing Aerospace and Electronics Co., Huntsville, AL.

SPACE STATION FLUID RESUPPLY

Al Winters *In* NASA, Washington, Technology for Space Station Evolution. Volume 3: EVA/Manned Systems/Fluid Management System 1990 p 225-240 (For primary document see N93-27786 10-18)

Avail: CASI HC A03/MF A03; 1 functional color page

Viewgraphs on space station fluid resupply are presented. Space Station Freedom is resupplied with supercritical O2 and N2 for the ECLSS and USL on a 180 day resupply cycle. Resupply fluids are stored in the subcarriers on station between resupply cycles and transferred to the users as required. ECLSS contingency fluids (O2 and N2) are supplied and stored on station in a gaseous state. Efficiency and flexibility are major design considerations. Subcarrier approach allows multiple manifest combinations. Growth is achieved by adding modular subcarriers. CASI

N93-27798*# Boeing Aerospace and Electronics Co., Huntsville, AL.

PROPULSION NEEDS FOR LUNAR/MARS MISSIONS **c20**

Gordon R. Woodcock *In* NASA, Washington, Technology for Space Station Evolution. Volume 3: EVA/Manned Systems/Fluid Management System 1990 p 241-260 (For primary document see N93-27786 10-18)

Avail: CASI HC A03/MF A03; 1 functional color page

Viewgraphs on propulsion needs for lunar/Mars missions are presented. Topics covered include: lunar mission profile; lunar transfer vehicle/lunar excursion vehicle; launch vehicles for lunar missions; lunar outpost; Mars transfer operations; Mars mission vehicle in low earth orbit (LEO); mission vehicle commonality; mass comparison for reference missions; advanced propulsion; propulsion option size comparison; Mars transfer vehicle (MTV) propulsion option weights for mission favorable opportunities; propulsion options comparison; Mars transportation architecture options; tanker options for fully reusable systems; NTR 900 Isp staged tanks and engines; fully reusable cryogenic aerobraked system; NEP operated from high orbit; and nuclear safe orbit considerations. CASI

N93-27799*# Martin Marietta Space Systems, Inc., Denver, CO.

SPACE STATION FLUID MANAGEMENT LOGISTICS

Sam M. Dominick *In* NASA, Washington, Technology for Space Station Evolution. Volume 3: EVA/Manned Systems/Fluid Management System 1990 p 261-291 (For primary document see N93-27786 10-18)

Avail: CASI HC A03/MF A03; 1 functional color page

Viewgraphs and discussion on space station fluid management logistics are presented. Topics covered include: fluid management logistics - issues

for Space Station Freedom evolution; current fluid logistics approach; evolution of Space Station Freedom fluid resupply; launch vehicle evolution; ELV logistics system approach; logistics carrier configuration; expendable fluid/propellant carrier description; fluid carrier design concept; logistics carrier orbital operations; carrier operations at space station; summary/status of orbital fluid transfer techniques; Soviet progress tanker system; and Soviet propellant resupply system observations. CASI

N93-27800*# Fairchild Space Co., Germantown, MD.
THE RESUPPLY INTERFACE MECHANISM
Barney F. Gorin *In* NASA, Washington, Technology for Space Station Evolution. Volume 3: EVA/Manned Systems/Fluid Management System 1990 p 293-305 (For primary document see N93-27786 10-18)
Avail: CASI HC A03/MF A03; 1 functional color page

Viewgraphs on the resupply interface mechanism are presented. The major servicing activities for any major asset are normal maintenance, consumable replenishment, repair of failed components, and preplanned product improvement. Spacecraft propulsion system resupply can be divided into three major issues: design for servicing, servicing technology, and mechanization. CASI

N93-27801*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ORBITAL STORAGE AND SUPPLY OF SUBCRITICAL LIQUID NITROGEN
John C. Aydelott *In* NASA, Washington, Technology for Space Station Evolution. Volume 3: EVA/Manned Systems/Fluid Management System 1990 p 307-321 (For primary document see N93-27786 10-18)
Avail: CASI HC A03/MF A03; 1 functional color page

Subcritical cryogenic fluid management has long been recognized as an enabling technology for key propulsion applications, such as space transfer vehicles (STV) and the on-orbit cryogenic fuel depots which will provide STV servicing capability. The LeRC Cryogenic Fluids Technology Office (CFTO), under the sponsorship of OAST, has the responsibility of developing the required technology via a balanced program involving analytical modeling, ground based testing, and in-space experimentation. Topics covered in viewgraph form include: cryogenic management technologies; nitrogen storage and supply; cryogenic nitrogen cooling capability; and LN2 system demonstration technical objectives. CASI

N93-27802*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
SUPERFLUID HELIUM NEEDS AND RESUPPLY ON SPACE STATION
Michael J. Dipirro *In* NASA, Washington, Technology for Space Station Evolution. Volume 3: EVA/Manned Systems/Fluid Management System 1990 p 323-353 (For primary document see N93-27786 10-18)
Avail: CASI HC A03/MF A03; 1 functional color page

Viewgraphs and discussion on superfluid helium needs and resupply on space station are presented. Topics covered include: uses of superfluid helium in space; space station He 2 technology issues; resupply - fluid management issues; liquid acquisition devices for on orbit transfer; and liquid acquisition devices for SHOOT. CASI

N93-27803*# National Aeronautics and Space Administration, Washington, DC.
TECHNOLOGY FOR SPACE STATION EVOLUTION. VOLUME 4: POWER SYSTEMS/PROPULSION/ROBOTICS
1990 476 p Workshop held in Dallas, TX, 16-19 Jan. 1990 Original contains color illustrations
(NASA-TM-108727; NAS 1.15:108727) Avail: CASI HC A21/MF A04; 1 functional color page

NASA's Office of Aeronautics and Space Technology (OAST) conducted a workshop on technology for space station evolution on 16-19 Jan. 1990. The purpose of this workshop was to collect and clarify Space Station Freedom technology requirements for evolution and to describe technologies that can potentially fill those requirements. These proceedings are organized into an Executive Summary and Overview and five volumes containing the Technology Discipline Presentations. Volume 4 consists of the technology discipline sections for Power, Propulsion, and Robotics. For each technology discipline, there is a Level 3 subsystem description, along with the papers. For individual titles, see N93-27804 through N93-27824.

N93-27804*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ELECTRICAL POWER SYSTEM WP-04 **c33**
Donald L. Nored *In* NASA, Washington, Technology for Space Station Evolution. Volume 4: Power Systems/Propulsion/Robotics 1990 p 5-61 (For primary document see N93-27803 10-18)
Avail: CASI HC A04/MF A04; 1 functional color page

Viewgraphs on Space Station Freedom Electrical Power System (EPS) WP-40 are presented. Topics covered include: key EPS technical requirements; photovoltaic power module systems; solar array assembly; blanket containment box and box positioning subassemblies; solar cell; bypass diode assembly; Kapton with atomic oxygen resistant coating; sequential shunt unit; gimbal assembly; energy storage subsystem; thermal control subsystem; direct current switching unit; integrated equipment assembly; PV cargo element; PMAD system; and PMC and AC architecture. CASI

N93-27805*# Rockwell International Corp., Canoga Park, CA. Rocketdyne Div.
SPACE STATION FREEDOM SOLAR DYNAMIC POWER GENERATION **c33**
T. Springer and Jerry M. Friefeld *In* NASA, Washington, Technology for Space Station Evolution. Volume 4: Power Systems/Propulsion/Robotics 1990 p 65-81 (For primary document see N93-27803 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

Viewgraphs on Space Station Freedom solar dynamic power generation are presented. Topics covered include: prime contract activity; key solar dynamic power module requirements; solar dynamic heat receiver technology; and solar concentrator advanced development. CASI

N93-27806*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ADVANCED SOLAR DYNAMIC TECHNOLOGY PROGRAM **c44**
James Calogeras *In* NASA, Washington, Technology for Space Station Evolution. Volume 4: Power Systems/Propulsion/Robotics 1990 p 83-115 (For primary document see N93-27803 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

Viewgraphs and discussion on Advanced Solar Dynamic Technology Program are presented. Topics covered include: advanced solar dynamic technology program; advanced concentrators; advanced heat receivers; power conversion systems; dished all metal honeycomb sandwich panels; Stirling cavity heat pipe receiver; Brayton solar receiver; and thermal energy storage technology. CASI

N93-27807*# Ford Aerospace Corp., Newport Beach, CA.
SPACE STATION FREEDOM ELECTRIC POWER SYSTEM EVOLUTIONARY ENERGY STORAGE **c33**
Mike Domeniconi *In* NASA, Washington, Technology for Space Station Evolution. Volume 4: Power Systems/Propulsion/Robotics 1990 p 117-121 (For primary document see N93-27803 10-18)
Avail: CASI HC A01/MF A04; 1 functional color page

Viewgraphs on Space Station Freedom electric power system evolutionary energy storage are presented. Topics covered include: system requirements evolution; Space Station Freedom timeline; development of technologies selection criteria; and candidate technologies. CASI

N93-27808*# TRW Defense and Space Systems Group, Redondo Beach, CA.
MINIATURIZED CASSEGRAINIAN SOLAR ARRAY DEVELOPMENT **c44**
R. Patterson and M. Mills *In* NASA, Washington, Technology for Space Station Evolution. Volume 4: Power Systems/Propulsion/Robotics 1990 p 123-128 Sponsored by NASA. Marshall Space Flight Center (For primary document see N93-27803 10-18)
Avail: CASI HC A02/MF A04; 1 functional color page

Viewgraphs on miniaturized Cassegrainian solar array development are presented. Topics covered include: miniature Cassegrainian concentrator (MCC) concept; folded box beam deployment of MCC array sub-wing; 100-kW MCC array system analysis summary; and array enables technology evolution. CASI

N93-27809*# Applied Solar Energy Corp., City of Industry, CA.
HIGH EFFICIENCY LOW COST GaAs/Ge CELL TECHNOLOGY **c33**

Frank Ho *In* NASA, Washington, Technology for Space Station Evolution. Volume 4: Power Systems/Propulsion/Robotics 1990 p 129-137 (For primary document see N93-27803 10-18)
Avail: CASI HC A02/MF A04; 1 functional color page

Viewgraphs on high efficiency low cost GaAs/Ge cell technology are presented. Topics covered include: high efficiency, low cost GaAs/Ge solar cells; advantages of Ge; comparison of typical production cells for space applications; panel level comparisons; and solar cell technology trends. CASI

N93-27810*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
GROWING THE SPACE STATION'S ELECTRICAL POWER PLANT c33
Gale R. Sundberg *In* NASA, Washington, Technology for Space Station Evolution. Volume 4: Power Systems/Propulsion/Robotics 1990 p 139-150 (For primary document see N93-27803 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

For over a decade NASA LeRC has been defining, demonstrating, and evaluating power electronic components and multi-kilowatt, multiply redundant, electrical power systems as part of OAST charter. Whether one considers aircraft (commercial transport/military), Space Station Freedom, growth station, launch vehicles, or the new Human Exploration Initiative, the conclusions remain the same: high frequency AC power distribution and control is superior to all other approaches for achieving a fast, smart, safe, versatile, and growable electrical power system that will meet a wide range of mission options. To meet the cost and operability goals of future aerospace missions that require significantly higher electrical power and longer durations, we must learn to integrate multiple technologies in ways that enhance overall system synergisms. The way NASA is doing business in space electric power is challenged and some approaches for evolving large space vehicles and platforms in well constructed steps to provide safe, ground testable, growable, smart systems that provide simple, replicative logic structures, which enable hardware and software verification, validation, and implementation are proposed. Viewgraphs are included. Author (revised)

N93-27811*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
ADVANCED MODULAR POWER SUPPLIES FOR SPACE STATION FREEDOM c20
S. Krauthamer, M. D. Gangal, and R. C. Detwiler *In* NASA, Washington, Technology for Space Station Evolution. Volume 4: Power Systems/Propulsion/Robotics 1990 p 151-199 (For primary document see N93-27803 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

Viewgraphs and discussion on advanced modular power supplies for Space Station Freedom are presented. Topics covered include concept and characteristics; user power supply applications; and bulk converter application. CASI

N93-27812*# Little (Arthur D.), Inc., Cambridge, MA.
POWER BEAMING OPTIONS FOR THE SPACE STATION c20
Peter E. Glaser *In* NASA, Washington, Technology for Space Station Evolution. Volume 4: Power Systems/Propulsion/Robotics 1990 p 201-212 (For primary document see N93-27803 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

Viewgraphs on power beaming options for the space station are presented. Topics covered include: power plant locations; beamed power options (lasers or microwaves); space power system technology; planned TSS experiment; microwave transmission experiment for space shuttle cargo bay; and power transmission configuration from space shuttle to free-flying platform. CASI

N93-27813*# Hamilton Standard, Windsor Locks, CT.
SPE (TM) REGENERATIVE HYDROGEN/OXYGEN FUEL CELLS FOR EXTRATERRESTRIAL SURFACE AND MICROGRAVITY APPLICATIONS c44
J. F. McElroy *In* NASA, Washington, Technology for Space Station Evolution. Volume 4: Power Systems/Propulsion/Robotics 1990 p 213-239 (For primary document see N93-27803 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

Viewgraphs on SPE regenerative hydrogen/oxygen fuel cells for extraterrestrial surface and microgravity applications are presented. Topics covered include: hydrogen-oxygen regenerative fuel cell energy storage system; electrochemical cell reactions; SPE cell voltage stability; passive water removal SPE fuel cell; fuel cell performance; SPE water electrolyzers; hydrophobic oxygen phase separator; hydrophilic/electrochemical hydrogen phase separator; and unitized regenerative fuel cell. CASI

N93-27814*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
INTEGRATED POWER AND ATTITUDE CONTROL SYSTEM (IPACS) TECHNOLOGY DEVELOPMENTS c20
David B. Eisenhaure (SatCon Technology Corp., Cambridge, MA.), Robert Bechtel, Richard Hockney (SatCon Technology Corp., Cambridge, MA.), Ron Oglevie, and Mitch Olszewski (Oak Ridge National Lab., TN.) *In* NASA, Washington, Technology for Space Station Evolution. Volume 4: Power Systems/Propulsion/Robotics 1990 p 241-273 (For primary document see N93-27803 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

Integrated Power and Attitude Control System (IPACS) studies performed over a decade ago established the feasibility of storing electrical energy in flywheels and utilizing the resulting angular momentum for spacecraft attitude control. Such a system has been shown to have numerous attractive features relative to more contemporary technology, and is appropriate to many applications (including high-performance slewing actuators). Technology advances over the last two decades in composite rotors, motor/generator/electronics, and magnetic bearings are found to support the use of IPACS for increasingly sophisticated applications. It is concluded that the concept offers potential performance advantages as well as savings in mass and life-cycle cost. Viewgraphs and discussion on IPACS are included. Derived from text

N93-27815*# International Fuel Cells Corp., South Windsor, CT.
FUEL CELL ENERGY STORAGE FOR SPACE STATION ENHANCEMENT c44
J. K. Stedman *In* NASA, Washington, Technology for Space Station Evolution. Volume 4: Power Systems/Propulsion/Robotics 1990 p 275-290 (For primary document see N93-27803 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

Viewgraphs on fuel cell energy storage for space station enhancement are presented. Topics covered include: power profile; solar dynamic power system; photovoltaic battery; space station energy demands; orbiter fuel cell power plant; space station energy storage; fuel cell system modularity; energy storage system development; and survival power supply. CASI

N93-27816*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
AUTOMATION OF SPACE STATION MODULE POWER MANAGEMENT AND DISTRIBUTION SYSTEM c20
Robert Bechtel, Dave Weeks, and Bryan Walls *In* NASA, Washington, Technology for Space Station Evolution. Volume 4: Power Systems/Propulsion/Robotics 1990 p 291-327 (For primary document see N93-27803 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

Viewgraphs on automation of space station module (SSM) power management and distribution (PMAD) system are presented. Topics covered include: reasons for power system automation; SSM/PMAD approach to automation; SSM/PMAD test bed; SSM/PMAD topology; functional partitioning; SSM/PMAD control; rack level autonomy; FRAMES AI system; and future technology needs for power system automation. CASI

N93-27817*# National Aeronautics and Space Administration, Washington, DC.
SPACE STATION PROPULSION SYSTEM c20
J. Henderson *In its* Technology for Space Station Evolution. Volume 4: Power Systems/Propulsion/Robotics 1990 p 331-357 (For primary document see N93-27803 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

Viewgraphs on space station propulsion systems are presented. Topics covered include: space station propulsion system requirements; space station propulsion system design; space station propulsion system drivers; hydrazine technology development; waste fluid disposal system; space station propulsion system evolution; propellant selection trade study; technology

needs to water electrolysis/oxygen-hydrogen propulsion system; and technology needs for bipropellant systems. CASI

N93-27818*# National Aeronautics and Space Administration, Washington, DC.

SPACE STATION PROPULSION INTEGRATED PROPULSION TEST ARTICLE **c20**

J. Henderson *In its* Technology for Space Station Evolution. Volume 4: Power Systems/Propulsion/Robotics 1990 p 361-369 (For primary document see N93-27803 10-18)

Avail: CASI HC A02/MF A04; 1 functional color page

Viewgraphs on space station propulsion integrated propulsion test articles are presented. Topics covered include: integrated propulsion test article; phase 1 configuration description; phase 2 testing; and electrolysis unit development contracts. CASI

N93-27819*# Hamilton Standard, Windsor Locks, CT.

SPE (TM) ELECTROLYZERS FOR SPACE PROPULSION **c20**

E. M. Shane *In* NASA, Washington, Technology for Space Station Evolution. Volume 4: Power Systems/Propulsion/Robotics 1990 p 371-397 (For primary document see N93-27803 10-18)

Avail: CASI HC A03/MF A04; 1 functional color page

Viewgraphs on SPE electrolyzers for space propulsion are presented. Topics covered include: SPE electrochemical cell reactions; SPE fuel cell/electrolyzer features; SPE cell life capability; SPE cell voltage stability; state-of-the-art SPE cell structure; electrolysis cell stack; electrolysis system; integrated propulsion test article-electrolyzer module components; and oxygen generator module. CASI

N93-27820*# Martin Marietta Space Systems, Inc., Denver, CO.

FLIGHT TELEROBOTIC SERVICER **c37**

Dennis Haley *In* NASA, Washington, Technology for Space Station Evolution. Volume 4: Power Systems/Propulsion/Robotics 1990 p 401-420 (For primary document see N93-27803 10-18)

Avail: CASI HC A03/MF A04; 1 functional color page

Viewgraphs on the Space Station Flight Telerobotic Servicer (SSFTS) are presented. Topics covered include: SSFTS design; SSFTS elements; FTS mission requirements; FTS general requirements; flight telerobotic servicer - telerobot; FTS manipulator; force-torque transducer; end effector changeout mechanism; flight telerobotic servicer - end-of-arm tooling; user interfaces; FTS data management and processing; control subsystem; FTS vision subsystem and camera positioning assembly; FTS workstation display assembly panel; mini-master hand controller; and FTS NASREM system architecture. CASI

N93-27821*# Canadian Space Agency, Ottawa (Ontario).

THE MOBILE SERVICING SYSTEM

David G. Hunter *In* NASA, Washington, Technology for Space Station Evolution. Volume 4: Power Systems/Propulsion/Robotics 1990 p 421-441 (For primary document see N93-27803 10-18)

Avail: CASI HC A03/MF A04; 1 functional color page

Viewgraphs on the mobile servicing system (MSS) are presented. Topics covered include: MSS overall configuration; MSS (space segment) hierarchy; functional requirements for special purpose dexterous manipulator (SPDM); SPDM configuration; objective of advanced technology development basic requirements for advanced technology; automation and robotics technologies MSS baseline; and automation and robotics technologies planned for incorporation. CASI

N93-27822*# Boeing Computer Services Co., Huntsville, AL. Artificial Intelligence Center.

AGENT-INDEPENDENT PLANNING

William S. Davis *In* NASA, Washington, Technology for Space Station Evolution. Volume 4: Power Systems/Propulsion/Robotics 1990 p 445-461 (For primary document see N93-27803 10-18)

Avail: CASI HC A03/MF A04; 1 functional color page

Viewgraphs and discussion on agent-independent planning are presented. Topics covered include: definitions; Space Station Freedom robotics environment; transition from crewmember to robots; agent-independent planning system flow; independence between plans and agents; existing testbed; benefits of approach; and directions of future research. CASI

N93-27823*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

SPACE TELEOPERATIONS TECHNOLOGY FOR SPACE STATION EVOLUTION

Gerald J. Reuter *In* NASA, Washington, Technology for Space Station Evolution. Volume 4: Power Systems/Propulsion/Robotics 1990 p 463-476 (For primary document see N93-27803 10-18)

Avail: CASI HC A03/MF A04; 1 functional color page

Viewgraphs on space teleoperations technology for space station evolution are presented. Topics covered include: shuttle remote manipulator system; mobile servicing center functions; mobile servicing center technology; flight telerobotic servicer-telerobot; flight telerobotic servicer technology; technologies required for space station assembly; teleoperation applications; and technology needs for space station evolution. CASI

N93-27824*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.

FTS EVOLUTION

David E. Provost *In* NASA, Washington, Technology for Space Station Evolution. Volume 4: Power Systems/Propulsion/Robotics 1990 p 481-502 (For primary document see N93-27803 10-18)

Avail: CASI HC A03/MF A04; 1 functional color page

Viewgraphs on flight telerobotic servicer evolution are presented. Topics covered include: paths for FTS evolution; frequently performed actions; primary task states; EPS radiator panel installation; generic task definitions; path planning; non-contact alignment; contact planning and control; and human operator interface. CASI

N93-27835*# National Aeronautics and Space Administration, Washington, DC.

TECHNOLOGY FOR SPACE STATION EVOLUTION. VOLUME 5: STRUCTURES AND MATERIALS/THERMAL CONTROL SYSTEM

1990 384 p Workshop held in Dallas, TX, 16-19 Jan. 1990 Original contains color illustrations

(NASA-TM-108728; NAS 1.15:108728) Avail: CASI HC A17/MF A03; 1 functional color page

NASA's Office of Aeronautics and Space Technology (OAST) conducted a workshop on technology for space station evolution on 16-19 Jan. 1990. The purpose of this workshop was to collect and clarify Space Station Freedom technology requirements for evolution and to describe technologies that can potentially fill those requirements. These proceedings are organized into an Executive Summary and Overview and five volumes containing the Technology Discipline Presentations. Volume 5 consists of the technology discipline sections for Structures/Materials and the Thermal Control System. For each technology discipline, there is a level 3 subsystem description, along with papers. For individual titles, see N93-27836 through N93-27846.

N93-27836*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

STRUCTURES FOR SPACE STATION FREEDOM: OVERVIEW OF CURRENT CONCEPT

Kornel Nagy *In* NASA, Washington, Technology for Space Station Evolution. Volume 5: Structures and Materials/Thermal Control System 1990 p 5-83 (For primary document see N93-27835 10-18)

Avail: CASI HC A03/MF A03; 1 functional color page

Viewgraphs on structures for Space Station Freedom are presented. The structures subsystem, mechanical subsystem, and evolution issues are addressed. CASI

N93-27837*# McDonnell-Douglas Space Systems Co., Houston, TX. Space Station Div.

STRUCTURAL TECHNOLOGY CHALLENGES FOR EVOLUTIONARY GROWTH OF SPACE STATION FREEDOM

Harold H. Doiron *In* NASA, Washington, Technology for Space Station Evolution. Volume 5: Structures and Materials/Thermal Control System 1990 p 87-111 (For primary document see N93-27835 10-18)

Avail: CASI HC A03/MF A03; 1 functional color page

A proposed evolutionary growth scenario for Space Station Freedom was defined recently by a NASA task force created to study requirements for a Human Exploration Initiative. The study was an initial response to President Bush's July 20, 1989 proposal to begin a long range program of human exploration of space including a permanently manned lunar base

and a manned mission to Mars. This growth scenario evolves Freedom into a critical transportation node to support lunar and Mars missions. The growth scenario begins with the Assembly Complete configuration and adds structure, power, and facilities to support a Lunar Transfer Vehicle (LTV) verification flight. Evolutionary growth continues to support expendable, then reusable LTV operations, and finally, LTV and Mars Transfer Vehicle (MTV) operations. The significant structural growth and additional operations creating new loading conditions will present new technological and structural design challenges in addition to the considerable technology requirements of the baseline Space Station Freedom program. Several structural design and technology issues of the baseline program are reviewed and related technology development required by the growth scenario is identified.

Author (revised)

N93-27838*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

APPROACHES TO DEALING WITH METEOROID AND ORBITAL DEBRIS PROTECTION ON THE SPACE STATION

Donald J. Kessler *In* NASA, Washington, Technology for Space Station Evolution. Volume 5: Structures and Materials/Thermal Control System 1990 p 115-165 (For primary document see N93-27835 10-18)

Avail: CASI HC A04/MF A03; 1 functional color page

Viewgraphs and discussion on approaches to dealing with meteoroid and orbital debris protection on the space station are presented. The National Space Policy of February, 1988, included the following: 'All sectors will seek to minimize the creation of space debris. Design and operations of space tests, experiments, and systems will strive to minimize or reduce accumulation of space debris consistent with mission requirements and cost effectiveness.' The policy also tasked the National Security Council, which established an Interagency Group, which in turn produced an Interagency Report. NASA and DoD tasks to establish a joint plan to determine techniques to measure the environment, and techniques to reduce the environment are addressed. Topics covered include: orbital debris environment, meteoroids, orbital debris population, cataloged earth satellite population, USSPACECOM cataloged objects, and orbital debris radar program.

Derived from text

N93-27839*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

AN EVOLUTIONARY CONSTRUCTION FACILITY FOR SPACE STATION FREEDOM

Richard M. Gates (Boeing Aerospace and Electronics Co., Seattle, WA.), Robert W. Buchan, and Laura M. Waters (Analytical Mechanics Associates, Inc., Jericho, NY.) *In* NASA, Washington, Technology for Space Station Evolution. Volume 5: Structures and Materials/Thermal Control System 1990 p 167-205 (For primary document see N93-27835 10-18)

Avail: CASI HC A03/MF A03; 1 functional color page

Viewgraphs and discussion on an evolutionary construction facility for Space Station Freedom are presented. Space Station Freedom (SSF) will support permanent human presence in space and has the potential to enable scientific and exploratory endeavors unequalled in history. With larger and more ambitious spacecraft being developed, it will serve as a site for construction, checkout, and deployment. A facility attached to SSF is required to develop and demonstrate the techniques that will enable on-orbit construction of future large spacecraft. Examples of attached scientific experiments that currently envision in-space construction and that are discussed are: Solar X-ray Pinhole Occulter Facility, Astromag, and X-ray Large Array. Examples of large assemblable spacecraft which are discussed are: Large Deployable Reflector (LDR), Geostationary Platforms, and interplanetary vehicles.

Derived from text

N93-27840*# Ohio State Univ., Columbus.

WELDING/BRAZING FOR SPACE STATION REPAIR

David W. Dickinson, H. W. Babel (McDonnell-Douglas Astronautics Co., Huntington Beach, CA.), H. R. Conaway (Rockwell International Corp., Canoga Park, CA.), and W. H. Hooper (Martin Marietta Corp., New Orleans, LA.) *In* NASA, Washington, Technology for Space Station Evolution. Volume 5: Structures and Materials/Thermal Control System 1990 p 207-267 (For primary document see N93-27835 10-18)

Avail: CASI HC A04/MF A03; 1 functional color page

Viewgraphs on welding/brazing for space station repair are presented. Topics covered include: fabrication and repair candidates; debris penetration of module panel; welded repair patch; mechanical assembly of utility fluid line; space station utility systems; Soviet aerospace fabrication - an overview; and processes under consideration.

CASI

N93-27841*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

PROBE (PRECISION REFLECTOR ORBITAL BUILD EXPERIMENT): A PROPOSED FLIGHT EXPERIMENT TO STUDY EVA ASSEMBLY OF PRECISION SEGMENTED REFLECTORS

Walter Heard *In* NASA, Washington, Technology for Space Station Evolution. Volume 5: Structures and Materials/Thermal Control System 1990 p 269-299 (For primary document see N93-27835 10-18)

Avail: CASI HC A03/MF A03; 1 functional color page

PROBE (Precision Reflector Orbital Build Experiment) is a Shuttle flight demonstration experiment designed to study extravehicular activity (EVA) assembly of precision segmented reflectors. PROBE will support missions being considered for NASA's Global Change Technology Initiative as well as other missions in astrophysics and spacecraft optical communications requiring large precision reflectors. Such reflectors are envisioned to consist of a low-mass backup truss to which the optical surface is attached. Because of their large size, these reflectors will be constructed on-orbit from smaller pieces which can be packaged in the launch vehicle. The technology to be developed with PROBE also has application for construction of solar dynamic collectors which are planned for the enhanced configuration of Space Station Freedom. Viewgraphs of PROBE are presented.

Derived from text

N93-27842*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

AUTOMATED ASSEMBLY OF LARGE SPACE STRUCTURES

Marvin D. Rhodes *In* NASA, Washington, Technology for Space Station Evolution. Volume 5: Structures and Materials/Thermal Control System 1990 p 301-323 (For primary document see N93-27835 10-18)

Avail: CASI HC A03/MF A03; 1 functional color page

Viewgraphs and discussion on automated assembly of large space structures are presented. The program research objective is to develop technology and demonstrate the potential for automated inspace assembly of large erectable structures. This is accomplished by merging experience in structural assembly and robotics at LaRC into an interdisciplinary program with focused effort on automated assembly of a generic structural configuration with a standard cell and by building into the system the capability to do expanded research with complex configurations.

Derived from text

N93-27843*# McDonnell-Douglas Astronautics Co., Huntington Beach, CA.

THERMAL SYSTEMS

J. E. Rogan *In* NASA, Washington, Technology for Space Station Evolution. Volume 5: Structures and Materials/Thermal Control System 1990 p 327-343 (For primary document see N93-27835 10-18)

Avail: CASI HC A03/MF A03; 1 functional color page

Viewgraphs on thermal systems for the Space Station Freedom are presented. Topics covered include: thermal control system; external thermal control system requirements; implementation approach; development issues; and thermal flight experiments.

CASI

N93-27844*# Creare, Inc., Hanover, NH.

ADVANCED INTERFACE HEAT EXCHANGERS FOR THE SPACE STATION MAIN THERMAL BUS

Javier A. Valenzuela *In* NASA, Washington, Technology for Space Station Evolution. Volume 5: Structures and Materials/Thermal Control System 1990 p 347-391 (For primary document see N93-27835 10-18)

(Contracts NAS9-17810; NAS9-17989; NAS9-18167)

Avail: CASI HC A03/MF A03; 1 functional color page

Future evolution and growth of the Space Station will place increasing demands on the thermal management system by the addition of new payloads and from increased activity in the habitat modules. To meet this need, Creare is developing advanced evaporators, condensors, and single-phase heat exchangers for operation in microgravity. The objective is to achieve a several-fold increase in the heat flux capability of these components, while operating at the same temperature difference as specified

for the present interface heat exchangers. Two prototype interface heat exchangers are presently being developed: one to interface the main thermal bus to a payload two-phase ammonia bus, and the other, to interface with the crew module single-phase water loop. The results achieved to date in the development of these heat exchangers are reviewed.

Derived from text

N93-27845*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

SPACE STATION FREEDOM CENTRAL THERMAL CONTROL SYSTEM EVOLUTION

Eric Olsson *In* NASA, Washington, Technology for Space Station Evolution. Volume 5: Structures and Materials/Thermal Control System 1990 p 393-412 Prepared in cooperation with Lockheed Engineering and Management Services Co., Inc., Houston, TX (For primary document see N93-27835 10-18)

Avail: CASI HC A03/MF A03; 1 functional color page

Viewgraphs on Space Station Freedom central thermal control system (CTCS) evolution are presented. Topics covered include: (1) growth requirements and basic features of research and development and transportation nodes; (2) identifying the principal CTCS hooks and scars at assembly complete to accommodate growth; and (3) describing the general provisions for growth and identifying pertinent design issues. CASI

N93-27846*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

ADVANCED AUTOMATION OF A PROTOTYPIC THERMAL CONTROL SYSTEM FOR SPACE STATION

Jeff Dominick *In* NASA, Washington, Technology for Space Station Evolution. Volume 5: Structures and Materials/Thermal Control System 1990 p 413-429 (For primary document see N93-27835 10-18)

Avail: CASI HC A03/MF A03; 1 functional color page

Viewgraphs on an advanced automation of a prototypic thermal control system for space station are presented. The Thermal Expert System (TEXSYS) was initiated in 1986 as a cooperative project between ARC and JCS as a way to leverage on-going work at both centers. JSC contributed Thermal Control System (TCS) hardware and control software, TCS operational expertise, and integration expertise. ARC contributed expert system and display expertise. The first years of the project were dedicated to parallel development of expert system tools, displays, interface software, and TCS technology and procedures by a total of four organizations.

Derived from text

N93-27854*# National Aeronautics and Space Administration, Washington, DC.

TECHNOLOGY FOR SPACE STATION EVOLUTION. EXECUTIVE SUMMARY AND OVERVIEW

1990 369 p Workshop held in Dallas, TX, 16-19 Jan. 1990 Original contains color illustrations

(NASA-TM-108724; NAS 1.15:108724) Avail: CASI HC A16/MF A03; 1 functional color page

NASA's Office of Aeronautics and Space Technology (OAST) conducted a workshop on technology for space station evolution 16-19 Jan. 1990. The purpose of this workshop was to collect and clarify Space Station Freedom technology requirements for evolution and to describe technologies that can potentially fill those requirements. These proceedings are organized into an Executive Summary and Overview and five volumes containing the technology discipline presentations. The Executive Summary and Overview contains an executive summary for the workshop, the technology discipline summary packages, and the keynote address. The executive summary provides a synopsis of the events and results of the workshop and the technology discipline summary packages. For individual titles, see N93-27855 through N93-27866.

N93-27855*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

ATTITUDE CONTROL AND STABILIZATION TECHNOLOGY DISCIPLINE

John W. Sunkel *In* NASA, Washington, Technology for Space Station Evolution. Executive Summary and Overview 1990 p 23-37 (For primary document see N93-27854 10-18)

Avail: CASI HC A03/MF A03; 1 functional color page

Viewgraphs on attitude control and stabilization technology discipline for the Space Station Freedom are presented. Topics covered include: attitude control technologies for multi-user accommodation; flexible dynamics and control; computational control techniques; and automatic proximity operations. CASI

N93-27856*# National Aeronautics and Space Administration, Washington, DC.

COMMUNICATIONS AND TRACKING TECHNOLOGY DISCIPLINE

Robert Romanofsky *In its* Technology for Space Station Evolution. Executive Summary and Overview 1990 p 39-58 (For primary document see N93-27854 10-18)

Avail: CASI HC A03/MF A03; 1 functional color page

Viewgraphs on communications and tracking technology discipline for Space Station Freedom are presented. The objective is to develop devices, components, and analytical methods to enhance and enable technology to meet space station evolutionary requirements for multiple access (proximity) communications, space-to-ground communications, and tracking as it pertains to rendezvous and docking as well as potential orbital debris warning systems. Topics covered include: optical communications and tracking; monolithic microwave integrated circuit systems; traveling wave tube technology; advanced modulation and coding; and advanced automation.

CASI

N93-27857*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

DATA MANAGEMENT SYSTEM TECHNOLOGY DISCIPLINE c82

Harry F. Benz *In* NASA, Washington, Technology for Space Station Evolution. Executive Summary and Overview 1990 p 59-83 (For primary document see N93-27854 10-18)

Avail: CASI HC A03/MF A03; 1 functional color page

Viewgraphs on data management system technology discipline for Space Station Freedom are presented. Topics covered include: systems technology area needs; storage technology area needs; processor technology area needs; communications technology area needs; software system technology area needs; human interface technology area needs; software development and verification; and onboard communications. CASI

N93-27858*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

ENVIRONMENTAL CONTROL AND LIFE SUPPORT SYSTEMS c54

Charles D. Ray *In* NASA, Washington, Technology for Space Station Evolution. Executive Summary and Overview 1990 p 85-101 (For primary document see N93-27854 10-18)

Avail: CASI HC A03/MF A03; 1 functional color page

Viewgraphs on Environmental Control and Life Support Systems (ECLSS) for Space Station Freedom are presented. Topics covered include: crew generated wastes processing and reclamation; water reclamation - pre- and post-treatment; simplified waste water processing; improved trace contaminant removal; and real time microbial analysis. CASI

N93-27859*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

EXTRAVEHICULAR ACTIVITY TECHNOLOGY DISCIPLINE c54

Bruce W. Webbon *In* NASA, Washington, Technology for Space Station Evolution. Executive Summary and Overview 1990 p 103-117 (For primary document see N93-27854 10-18)

Avail: CASI HC A03/MF A03; 1 functional color page

Viewgraphs on extravehicular activity technology discipline for Space Station Freedom are presented. Topics covered include: extravehicular mobility unit; airlock and EMU support equipment; tools, mobility aids, and workstations; and telerobotic work aids interfaces. CASI

N93-27860*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

MANNED SYSTEMS TECHNOLOGY DISCIPLINE c54

Remus Bretoi *In* NASA, Washington, Technology for Space Station Evolution. Executive Summary and Overview 1990 p 119-140 (For primary document see N93-27854 10-18)

Avail: CASI HC A03/MF A03; 1 functional color page

Viewgraphs on manned systems technology discipline for Space Station Freedom are presented. Topics covered include: crew-systems interfaces

and interactions; crew training; on-board systems maintenance and support; habitability and environment; and computational human factors. CASI

N93-27861*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
FLUID MANAGEMENT SYSTEM TECHNOLOGY DISCIPLINE
E. Patrick Symons *In* NASA, Washington, Technology for Space Station Evolution. Executive Summary and Overview 1990 p 141-156 (For primary document see N93-27854 10-18)
Avail: CASI HC A03/MF A03; 1 functional color page
Viewgraphs on fluid management system technology discipline for Space Station Freedom are presented. Topics covered include: subcritical cryogenic storage and transfer; fluid handling; and components and instrumentation. CASI

N93-27862*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
POWER SYSTEM TECHNOLOGY DISCIPLINE
Henry Brandhorst *In* NASA, Washington, Technology for Space Station Evolution. Executive Summary and Overview 1990 p 157-178 (For primary document see N93-27854 10-18)
Avail: CASI HC A03/MF A03; 1 functional color page
Viewgraphs on power system technology discipline for Space Station Freedom are presented. Topics covered include: power generation subsystem; energy storage subsystem; and power distribution. CASI

N93-27863*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
PROPULSION TECHNOLOGY DISCIPLINE c20
Lee W. Jones *In* NASA, Washington, Technology for Space Station Evolution. Executive Summary and Overview 1990 p 179-196 (For primary document see N93-27854 10-18)
Avail: CASI HC A03/MF A03; 1 functional color page
Viewgraphs on propulsion technology discipline for Space Station Freedom are presented. Topics covered include: water electrolysis O2/H2 system; hydrazine system advancements; common technology; fluids disposal; and storable bipropellant system. CASI

N93-27864*# National Aeronautics and Space Administration, Washington, DC.
ROBOTICS TECHNOLOGY DISCIPLINE c37
Melvin D. Montemerlo *In its* Technology for Space Station Evolution. Executive Summary and Overview 1990 p 197-233 (For primary document see N93-27854 10-18)
Avail: CASI HC A03/MF A03; 1 functional color page
Viewgraphs on robotics technology discipline for Space Station Freedom are presented. Topics covered include: mechanisms; sensors; systems engineering processes for integrated robotics; man/machine cooperative control; 3D-real-time machine perception; multiple arm redundancy control; manipulator control from a movable base; multi-agent reasoning; and surfacing evolution technologies. CASI

N93-27865*# National Aeronautics and Space Administration, Washington, DC.
STRUCTURES AND MATERIALS TECHNOLOGY DISCIPLINE
Robert J. Hayduk *In its* Technology for Space Station Evolution. Executive Summary and Overview 1990 p 235-245 (For primary document see N93-27854 10-18)
Avail: CASI HC A03/MF A03; 1 functional color page
Viewgraphs on structures and materials technology discipline for Space Station Freedom are presented. Topics covered include: spacecraft materials; space construction; and structural dynamics. CASI

N93-27866*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
THERMAL CONTROL SYSTEM TECHNOLOGY DISCIPLINE
Wilbert E. Ellis *In* NASA, Washington, Technology for Space Station Evolution. Executive Summary and Overview 1990 p 247-265 (For primary document see N93-27854 10-18)
Avail: CASI HC A03/MF A03; 1 functional color page
Viewgraphs on thermal control systems technology discipline for Space Station Freedom are presented. Topics covered include: heat rejection; heat acquisition and transport; monitoring and control; passive thermal control; and analysis and test verification. CASI

N93-27946# Technische Univ., Delft (Netherlands).
THE USE OF SATELLITES IN GRAVITY FIELD DETERMINATION AND MODEL ADJUSTMENT Ph.D. Thesis
Petrus Nicolaas Anna Visser 1992 223 p Sponsored in part by ESA
(ISBN-90-6275-802-9/CIP; ETN-93-93666) Copyright Avail: CASI HC A10/MF A03
Methods to improve gravity field models of the Earth with available data from satellite observations are proposed and discussed. In principle, all types of satellite observations mentioned give information of the satellite orbit perturbations and in conjunction the Earth's gravity field, because the satellite orbits are affected most by the Earth's gravity field. Therefore, two subjects are addressed: representation forms of the gravity field of the Earth and the theory of satellite orbit perturbations. An analytical orbit perturbation theory is presented and shown to be sufficiently accurate for describing satellite orbit perturbations if certain conditions are fulfilled. Gravity field adjustment experiments using the analytical orbit perturbation theory are discussed using real satellite observations. These observations consisted of Seasat laser range measurements and crossover differences, and of Geosat altimeter measurements and crossover differences. A look into the future, particularly relating to the ARISTOTELES (Applications and Research Involving Space Techniques for the Observation of the Earth's field from Low Earth Orbit Spacecraft) mission, is given. ESA

N93-28248# Naval Postgraduate School, Monterey, CA.
ACTIVE DAMPING CONTROL OF A FLEXIBLE SPACE STRUCTURE USING PIEZOELECTRIC SENSORS AND ACTUATORS M.S. Thesis
Scott M. Newman Dec. 1992 74 p
(AD-A262884) Avail: CASI HC A04/MF A01
This thesis details the experimental analysis of an active damping control technique applied to the Naval Postgraduate School's Flexible Spacecraft simulator using piezoceramic sensors and actuators. The mass property of the flexible arm is varied to study the frequency effects on the Positive Position Feedback (PPF) algorithm. Multi-modal dynamic response is analytically studied using a finite-element model of a cantilevered beam while under the influence of three different control laws: a basic law derived from the Lyapunov Stability Theorem, PPF, and Strain Rate Feedback (SRF). The advantages and disadvantages of using PPF and SRF for active damping control are discussed. DTIC

N93-28323*# Teledyne Brown Engineering, Huntsville, AL.
SPACE STATION FURNACE FACILITY. VOLUME 2: SUMMARY OF TECHNICAL REPORTS Final Report
May 1992 323 p
(Contract NAS8-38077)
(NASA-CR-192534; NAS 1.26:192534) Avail: CASI HC A14/MF A03
The Space Station Furnace Facility (SSFF) is a modular facility for materials research in the microgravity environment of the Space Station Freedom (SSF). The SSFF is designed for crystal growth and solidification research in the fields of electronic and photonic materials, metals and alloys, and glasses and ceramics, and will allow for experimental determination of the role of gravitational forces in the solidification process. The facility will provide a capability for basic scientific research and will evaluate the commercial viability of low-gravity processing of selected technologically important materials. In order to accommodate the furnace modules with the resources required to operate, SSFF developed a design that meets the needs of the wide range of furnaces that are planned for the SSFF. The system design is divided into subsystems which provide the functions of interfacing to the SSF services, conditioning and control for furnace module use, providing the controlled services to the furnace modules, and interfacing to and acquiring data from the furnace modules. The subsystems, described in detail, are as follows: Power Conditioning and Distribution Subsystem; Data Management Subsystem; Software; Gas Distribution Subsystem; Thermal Control Subsystem; and Mechanical Structures Subsystem. Derived from text

N93-28401# Maxwell Labs., Inc., La Jolla, CA. S-Cubed Div.
ANALYSIS OF DYNAMICAL PLASMA INTERACTIONS WITH HIGH-VOLTAGE SPACECRAFT, VOLUME 1 Final Report, 31 Dec. 1988 - 31 Dec. 1991
M. J. Mandell, T. Luu, J. Lilley, G. Jongeward, and I. Katz Jun. 1992 183 p
(Contract F19628-89-C-0032)
(AD-A262783; PL-TR-92-2248-Vol-1) Avail: CASI HC A09/MF A02

This volume describes numerous plasma interaction problems done in support of DynaPAC code development, and in support of the SPEAR-II and SPEAR-3 programs. Two dimensional calculations show that oscillations of a beam emitted into an underdense plasma can cause overcharging of a beam emitting rocket, as was observed on MAIMIK. The effects of the sheath instability caused by orbital motion of a positive body are studied, showing that substantial potential oscillations occur, and that the electron current to the probe is enhanced. The plasma response to a sudden application of negative voltage to a probe is studied. It takes a long time to establish an equilibrium sheath, and early time ion currents can be enhanced by an order of magnitude. We calculate currents to the SPEAR-II high voltage probe, explaining the observed difference in probe reading between vacuum and plasma conditions. A one-dimensional model estimates the neutral density required for breakdown of a negative sheath, as proposed for SPEAR-3. We show calculations of the SPEAR-3 rocket floating potentials, collected currents, and current distribution to the particle detectors. Finally, DynaPAC calculations for the sheath structure around the TSS-1 subsatellite are presented. DTIC

N93-28402# Maxwell Labs., Inc., La Jolla, CA. S-Cubed Div.
ANALYSIS OF DYNAMICAL PLASMA INTERACTIONS WITH HIGH-VOLTAGE SPACECRAFT, VOLUME 2 Final Report, 31 Dec. 1988 - 31 Dec. 1991
M. J. Mandell, T. Luu, and J. Lilley Jun. 1992 128 p
(Contract F19628-89-C-0032)
(AD-A262784; PL-TR-92-2248-Vol-2) Avail: CASI HC A07/MF A02

This volume is the users' and programmers' manual for the DynaPAC computer code. DynaPAC is a user-friendly and programmer-friendly workbench for studying plasma interactions with realistic spacecraft in three dimensions. DynaPAC enables plasma interactions specialists to perform predictive scientific calculations with direct application to engineering problems. DynaPAC uses a finite element algorithm with strictly continuous electric fields for accurate potential calculation and particle tracking, and contains a powerful database utility for storage and communication of large data arrays. The core capabilities of DynaPAC are (1) to define the spacecraft geometry and the structure of the computational space; (2) to solve the electrostatic potential about the object with space charge computed either fully by particles, fully analytically, or in a hybrid manner; and (3) to generate and track representative macroparticles in the computational space. The core modules are designed to have the maximum practical user control and to facilitate the incorporation of new or modified algorithms. Preprocessors are provided to set boundary conditions and generate input files in a modern, screen-oriented way. Similarly, screen-oriented postprocessors are provided for graphical and textual data display. DTIC

N93-27176 Israel Aircraft Industries Ltd., Beer-Yaaqov. Aeromechanical Dept.
CRYOGENIC TRANSFER MODULE FOR GEOSYNCHRONOUS ORBIT
Claude Oiknine *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 65-77 (For primary document see N93-27166 10-01)
Copyright Avail: Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel

N93-27191 Technion - Israel Inst. of Tech., Haifa. Faculty of Aerospace Engineering.
AN EFFICIENT SOLUTION PROCEDURE FOR THE THERMOELASTIC ANALYSIS OF TRUSS SPACE STRUCTURES
D. Givoli and O. Rand *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 207-213 (For primary document see N93-27166 10-01)
Copyright Avail: Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel

N93-27192 Technion - Israel Inst. of Tech., Haifa. Faculty of Aerospace Engineering.
PASSIVE DAMPING AUGMENTATION OF FLEXIBLE BEAM-LIKE LATTICE TRUSSES FOR LARGE SPACE STRUCTURES
K. Cohen and T. Weller *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 214-225 (For primary document see N93-27166 10-01)
Copyright Avail: Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel

N93-27195 Israel Aircraft Industries Ltd., Yehud. Faculty of Aerospace Engineering.
ATTITUDE STABILIZATION OF BIAS MOMENTUM SATELLITES
Marcel Sidi *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 243-251 (For primary document see N93-27166 10-01)
Copyright Avail: Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel

N93-27196 Technion - Israel Inst. of Tech., Haifa.
DYNAMICS AND CONTROL OF A FREE FLYING TWO ARMED ROBOT IN SPACE Abstract Only
Liron Ernwald, M. Guelman (Rafael Armament Development Authority, Haifa, Israel.), and P. T. L. M. vanWoerkom (National Aerospace Lab., Amsterdam, Netherlands.) *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 252-253 (For primary document see N93-27166 10-01)
Copyright Avail: Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel

N93-27197 Technion - Israel Inst. of Tech., Haifa. Faculty of Aerospace Engineering.
TechSAT ATTITUDE CONTROL
M. Shachar and R. Vansover *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 254-265 (For primary document see N93-27166 10-01)
Copyright Avail: Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel

N93-27198 Israel Aircraft Industries Ltd., Yehud. Space Technology Dept.
OFEQ-2 ORBIT, ATTITUDE, AND FLIGHT EVALUATION
Michael Grumer, Joseph Komem, Joseph Kronenfeld, Ophir Kubitski, Vitaly Lorber, and Haim Shyldkrot *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 266-278 (For primary document see N93-27166 10-01)
Copyright Avail: Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel

N93-27199 Universidade Estadual de Paulista, Guaratingueta (Brazil). Dept. de Matematica.
EFFECTS OF SOLAR RADIATION PRESSURE TORQUE ON THE ROTATIONAL MOTION OF AN ARTIFICIAL SATELLITE
M. Cecilia F. P. S. Zanardi and Rodolpho VilhenadeMoraes (ITA Astronomical Observatory, Sao Jose dos Campos, Brazil.) *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 279-286 (For primary document see N93-27166 10-01)
Copyright Avail: Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel

N93-27200 Israel Aircraft Industries Ltd., Yehud. MBT.
MINIMUM NUMBER OF SATELLITES FOR EARTH COVERAGE BY A CONSTELLATION OF LOW-ORBIT SATELLITES
Marcel Sidi and Yoram Yaniv *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 287-294 (For primary document see N93-27166 10-01)
Copyright Avail: Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel

N93-27203 Israel Aircraft Industries Ltd., Yehud. Systems and Space Technology.
SOLAR SAIL ATTITUDE CONTROL INCLUDING ACTIVE NUTATION DAMPING IN A FIXED-MOMENTUM WHEEL SATELLITE
Ruth Azor *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 311-317 (For primary document see N93-27166 10-01)
Copyright Avail: Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel

N93-28016# Mitsubishi Electric Corp., Kamakura (Japan). Kamakura Works.
MANNED ENGINEERING TEST SATELLITES [YUUJIN GIJUTSU SHIKEN EISEI]
Hiromi Seko, Masao Satou, Hisao Tomoeda, Hiroaki Obara, and Katsutoshi Oomura *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 22 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

N93-28017# Nippon Electric Co. Ltd., Tokyo (Japan).
CONCEPTUAL STUDY ON MANNED ENGINEERING TEST SATELLITES [YUUJIN GIJITSU SHIKEN EISEI NO GAINEN KENTOU]
Tsuyoshi Okazaki, Tooru Nakano (Nippon Electric Co. Ltd., Tokyo, Japan.), Masabumi Inomata (Nippon Electric Co. Ltd., Tokyo, Japan.), Jun Inagaki (Nippon Electric Co. Ltd., Tokyo, Japan.), and Shigeru Oono (Nippon Electric Co. Ltd., Tokyo, Japan.) *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 21 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

N93-28018# Nissan Motor Co. Ltd., Tokyo (Japan).
ARTIFICIAL GRAVITY EXPERIMENT SATELLITES [JINKOU JUURYOKU JIKKEN EISEI]
Tadashi Harada *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 21 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

N93-28019# Fujitsu Ltd., Tokyo (Japan).
LINEARLY CONNECTED SOLAR POWER SATELLITE [CHOKUSEN RENKETSUGATA TAIYOU HATSUDEN EISEI]
Tetsuji Narasaki and Yoshikazu Doui *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 14 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

N93-28020# Mitsubishi Electric Corp., Tokyo (Japan).
STUDY OF SATELLITE MICROMINIATURIZATION TECHNOLOGY [EISEI CHOUKOGATAKA GIJUTSU NO KENTOU]
Hiroaki Obara and Katsutoshi Oomura *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 10 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A02/MF A06

N93-28021# Nippon Electric Co. Ltd., Tokyo (Japan). Aerospace Systems, Ltd.
STUDY OF SATELLITE MICROMINIATURIZATION TECHNOLOGY [EISEI CHOUKOGATAKA GIJUTSU NO KENTOU]
Akihiko Kimura, Yukio Matsufuji, and Osamu Nakagawa *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 19 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

N93-28022# Hitachi Ltd., Tokyo (Japan).
STUDY OF MINIATURE AND MICROMINIATURE SATELLITE TECHNOLOGY [KOGATA/CHOUKOGATA EISEI GIJUTSU NO KENTOU]
Kazuhisa Kaneko *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 18 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

N93-28023# Toshiba Corp., Tokyo (Japan).
DEBRIS OBSERVATION AND ARRESTING EXPERIMENT SATELLITE [DEBURI KANSOKU/HOKAKU JIKKEN EISEI]
Toshinori Yukawa *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 23 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

N93-28024# Ishikawajima-Harima Heavy Industries Co. Ltd., Tokyo (Japan).
CONCEPTUAL STUDY OF DEBRIS OBSERVATION AND ARRESTING EXPERIMENT SATELLITE [DEBURI KANSOKU/HOKAKU JIKKEN EISEI NO GAINEN KENTOU]
Kenichi Kimoto, Hatsuo Mori, Keiichi Satou, Yukihito Kitazawa, and Kouichi Miyoshi *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 22 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

N93-28025# Hitachi Ltd., Tokyo (Japan). Hitachi Works.
CONCEPTUAL STUDY OF PROPELLANT STORAGE AND TRANSFER ENGINEERING TEST SATELLITE [SUISHINZAI CHOZOU/ISOU GIJUTSU SHIKEN EISEI NO GAINEN KENTOU]
Yuusuke Ueda, Ryuusuke Abe, Tsunehiko Takakusaki, and Kazutake Imajin *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 17 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

N93-28026# Kawasaki Heavy Industries Ltd., Kobe (Japan).
CONCEPTUAL STUDY OF FLY-BACK BOOSTER [FURAI BAKKU BUSUTA NO GAINEN KENTOU]
Hikaru Tomita and Kouichi Yonemoto *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 19 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

N93-28027# Nissan Motor Co. Ltd., Tokyo (Japan).
FLY-BACK BOOSTER [FURAI BAKKU BUSUTA]
Takashi Makino *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 16 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

N93-28028# Mitsubishi Heavy Industries Ltd., Nagoya (Japan). Nagoya Aerospace Systems Works.
CONCEPTUAL STUDY OF FLY-BACK BOOSTER [FURAI BAKKU BUSUTA NO GAINEN KENTOU]
Ryuuichi Minami *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 14 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

N93-28036# National Space Development Agency, Ibaraki (Japan).
CONCEPTUAL STUDY OF THE MOON REVOLVING OBSERVATION SATELLITES [TSUKI SHUUKAI KANSOKU EISEI NO GAINEN KENTOU]
Takeshi Kawazoe *In its* Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 17 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

N93-28037# Toshiba Corp., Tokyo (Japan).
MOON REVOLVING OBSERVATION SATELLITES [TSUKI SHUUKAI KANSOKU EISEI]
Hidenori Nagata, Nobuaki Nagaoka, and Megumi Suzaki *In its* Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 21 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

N93-28038# Nihon ESPEC (Japan).
MOON REVOLVING OBSERVATION SATELLITE [TSUKI SHUUKAI KANSOKU EISEI]

Reiji Katane and Tsuyoshi Okazaki *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 22 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

N93-28043# Ishikawajima-Harima Heavy Industries Co. Ltd., Tokyo (Japan).
CONCEPTUAL STUDY OF LUNAR LANDING MODULES [GETSUMEN CHAKURIKUKI NO GAINEN KENTOU]
Koutarou Shiina, Shunichirou Nakai, Yukihito Kitazawa, Tsumeo Kawai, and Kazuyuki Higashino *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 22 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

N93-28047# Hitachi Ltd., Tokyo (Japan).
MARS REVOLVING OBSERVATION SATELLITE [KASEI SHUUKAI KANSOKU EISEI]
Minako Tajima *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 18 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

19 SPACECRAFT INSTRUMENTATION

For related information see also *06 Aircraft Instrumentation* and *35 Instrumentation and Photography.*

N93-27194 Technion - Israel Inst. of Tech., Haifa. Faculty of Aerospace Engineering.
ENHANCED ORBITAL GYROCOMPASSING BY THE OPTICAL FLOW SENSED BY AN EARTH-POINTING CAMERA
Leora Topaz and Arthur J. Grunwald *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 229-242 (For primary document see N93-27166 10-01)
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20 SPACECRAFT PROPULSION AND POWER

Includes main propulsion systems and components, e.g., rocket engines; and spacecraft auxilliary power sources.

For related information see also *07 Aircraft Propulsion and Power, 28 Propellants and Fuels, 44 Energy Production and Conversion,* and *15 Launch Vehicles and Space Vehicles.*

N93-26703*# Sverdrup Technology, Inc., Brook Park, OH.
A PHOTOVOLTAIC CATENARY-TENT ARRAY FOR THE MARTIAN SURFACE Final Report
Anthony J. Colozza, J. Appelbaum (Tel-Aviv Univ., Israel.), and M. Crutchik (Tel-Aviv Univ., Israel.) May 1993 7 p Presented at the 23rd IEEE Photovoltaic Specialists Conference, Louisville, KY, 10-14 May, 1993; sponsored by the Electron Devices Society
(Grant NAGw-2022; RTOP 326-81-10)
(NASA-CR-191144; E-7865; NAS 1.26:191144) Avail: CASI HC A02/MF A01

To provide electrical power during an exploration mission to Mars, a deployable tent-shaped structure with a flexible photovoltaic (PV) blanket is proposed. The array is designed with a self-deploying mechanism utilizing pressurized gas expansion. The structural design for the array uses a combination of cables, beams, and columns to support and deploy the PV blanket. Under the force of gravity, a cable carrying a uniform load will take the shape of a catenary curve. A catenary-tent collector is self shading which must be taken into account in the solar radiation calculation. The shape and the area of the shadow on the array was calculated and used in the determination of the global irradiance on the array. The PV blanket shape and structure dimensions were optimized to achieve a configuration which maximizes the specific power (W/kg). The optimization was performed for three types of PV blankets (silicon, gallium arsenide over germanium, and amorphous silicon) and two types of structural materials (carbon composite and arimid fiber composite). The results show that the catenary shape of the PV blanket corresponding to zero end angle at the base with respect to the horizontal results in the highest specific power. The tent angle is determined by optimizing the specific mass and the output power for maximum specific power. The combination of carbon fiber structural material and amorphous silicon blanket produces the highest specific power. Author (revised)

N93-26908*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
NUCLEAR PROPULSION TECHNICAL INTERCHANGE MEETING, VOLUME 1
1993 567 p Meeting held in Sandusky, OH, 20-23 Oct. 1992
(RTOP 506-49-00)
(NASA-CP-10116-Vol-1; E-7638-Vol-1; NAS 1.55:10116-Vol-1) Avail: CASI HC A24/MF A04

The Nuclear Propulsion Technical Interchange Meeting (NP-TIM-92) was sponsored and hosted by the Nuclear Propulsion Office at the NASA Lewis Research Center. The purpose of the meeting was to review the work performed in fiscal year 1992 in the areas of nuclear thermal and nuclear electric propulsion technology development. These proceedings are a compilation of the presentations given at the meeting (many of the papers are presented in outline or viewgraph form). Volume 1 covers the introductory presentations and the system concepts and technology developments related to nuclear thermal propulsion. For individual titles, see N93-26909 through N93-26939.

N93-26909*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
MARS EXPLORATION PROGRAM
Dwayne Weary *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 1 1993 p 2-9 (For primary document see N93-26908 10-20)
Avail: CASI HC A02/MF A04

An overview of the Mars Exploration Program is presented in outline and graphic form. Mission objectives, mission strategy, operations concept, transportation element, launch vehicle considerations and program schedule are addressed. CASI

N93-26910*# National Aeronautics and Space Administration, Washington, DC.
SOLAR SYSTEM EXPLORATION DIVISION: REQUIREMENTS FOR SPACE NUCLEAR PROPULSION
Douglas Stetson *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 1 1993 p 10-15 (For primary document see N93-26908 10-20)
Avail: CASI HC A02/MF A04

The rationale and requirements for space nuclear propulsion (SNP) are outlined. Some specific nuclear electric propulsion requirements for planned planetary missions and low-power missions are given. CASI

N93-26911*# Phillips Lab., Edwards AFB, CA.
DOD REQUIREMENTS FOR SPACE NUCLEAR THERMAL PROPULSION
Gary A. Bleeker *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 1 1993 p 16-19 (For primary document see N93-26908 10-20)
Avail: CASI HC A01/MF A04

Potential DOD applications of nuclear thermal propulsion are listed and the performance goals and cost benefits of these propulsion systems are outlined. CASI

N93-26912*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
FOCUSED TECHNOLOGY: NUCLEAR PROPULSION
Thomas J. Miller *In its* Nuclear Propulsion Technical Interchange Meeting, Volume 1 1993 p 21-23 (For primary document see N93-26908 10-20)
Avail: CASI HC A01/MF A04

Five viewgraphs are presented that outline the objectives and elements of the Nuclear Propulsion Program, mission considerations, propulsion

technologies, and the logic flow path for nuclear propulsion development. CASI

N93-26913*# Department of Energy, Washington, DC. Space and Defense Power Systems.
OVERVIEW OF DOE SPACE NUCLEAR PROPULSION PROGRAMS
Alan R. Newhouse *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 1 1993 p 24-33 (For primary document see N93-26908 10-20)
Avail: CASI HC A02/MF A04

An overview of Department of Energy space nuclear propulsion programs is presented in outline and graphic form. DOE's role in the development and safety assurance of space nuclear propulsion is addressed. Testing issues and facilities are discussed along with development needs and recent research activities. CASI

N93-26914*# Phillips Lab., Edwards AFB, CA.
SPACE NUCLEAR THERMAL PROPULSION (SNTP) PROGRAM
Gary A. Bleeker *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 1 1993 p 34-40 (For primary document see N93-26908 10-20)
Avail: CASI HC A02/MF A04

An overview of the Space Nuclear Thermal Propulsion program is presented in graphic form. A program organizational chart is presented that shows the government and industry participants. Enabling technologies and test facilities and approaches are also addressed. CASI

N93-26915*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
SYSTEMS OVERVIEW
Robert Corban *In its* Nuclear Propulsion Technical Interchange Meeting, Volume 1 1993 p 42-47 (For primary document see N93-26908 10-20)
Avail: CASI HC A02/MF A04

Charts and accompanying text are presented that provide a brief synopsis of the contracted efforts for FY-92 in assessing nuclear thermal propulsion requirements, concepts, and associated issues. The objective of the effort is to provide NASA LeRC with assistance in space nuclear propulsion system requirements management and public acceptance planning. CASI

N93-26916*# Analytical Engineering Corp., North Olmsted, OH.
REQUIREMENTS MANAGEMENT AND CONTROL
Red Robbins *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 1 1993 p 48-52 (For primary document see N93-26908 10-20)
Avail: CASI HC A01/MF A04

The systems engineering process for thermal nuclear propulsion requirements and configuration definition is described in outline and graphic form. Functional analysis and mission attributes for a Mars exploration mission are also addressed. CASI

N93-26917*# Analytical Engineering Corp., North Olmsted, OH.
NUCLEAR SYSTEMS IN SPACE? DOES/WILL THE PUBLIC ACCEPT THEM?
Harold B. Finger *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 1 1993 p 53-66 (For primary document see N93-26908 10-20)
Avail: CASI HC A03/MF A04

Public attitudes toward the use of nuclear energy on earth and in space are discussed. Survey data are presented which show that the public believes nuclear energy should play an important role in our energy supply. However, based on broad attitude research, there should be no expectation that the public will accept or support the use of nuclear energy unless it meets special needs and offers special and significant benefits. It is proposed that a public information program be adopted that results in getting recognition and support for the space program broadly and for the missions that benefit substantially from or require nuclear energy for their accomplishment. CASI

N93-26918*# Rockwell International Corp., Canoga Park, CA. Rocketdyne Div.
ROVER/NERVA-DERIVED NEAR-TERM NUCLEAR PROPULSION Final Review, FY 1992
In NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 1 1993 p 67-149 Prepared in cooperation with Westinghouse Electric Corp., Pittsburgh, PA (For primary document see N93-26908 10-20)
Avail: CASI HC A05/MF A04

FY-92 accomplishments centered on conceptual design and analyses for 25, 50, and 75 K engines with emphasis on the 50 K engine. During the first period of performance, flow and energy balances were prepared for each of these configurations and thrust-to-weight values were estimated. A review of fuel technology and key data from the Rover/NERVA program established a baseline for proven reactor performance and areas of enhancement to meet near-term goals. Studies were performed of the criticality and temperature profiles for probable fuel and moderator loadings for the three engine sizes, with a more detailed analysis of the 50 K size. During the second period of performance, analyses of the 50 K engine continued. A chamber/nozzle contour was selected and heat transfer and fatigue analyses were performed for likely construction materials. Reactor analyses were performed to determine component radiation heating rates, reactor radiation fields, water immersion poisoning requirements, temperature limits for restartability, and a tie-tube thermal analysis. Finally, a brief assessment of key enabling technologies was made, with a view toward identifying development issues and identification of the critical path toward achieving engine qualification within 10 years. Derived from text

N93-26919*# Pratt and Whitney Aircraft, West Palm Beach, FL.
ADVANCED PROPULSION ENGINE ASSESSMENT BASED ON A CERMET REACTOR
Randy C. Parsley *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 1 1993 p 150-216 (For primary document see N93-26908 10-20)
Avail: CASI HC A04/MF A04

A preferred Pratt & Whitney conceptual Nuclear Thermal Rocket Engine (NTRE) has been designed based on the fundamental NASA priorities of safety, reliability, cost, and performance. The basic philosophy underlying the design of the XNR2000 is the utilization of the most reliable form of ultrahigh temperature nuclear fuel and development of a core configuration which is optimized for uniform power distribution, operational flexibility, power maneuverability, weight, and robustness. The P&W NTRE system employs a fast spectrum, cermet fueled reactor configured in an expander cycle to ensure maximum operational safety. The cermet fuel form provides retention of fuel and fission products as well as high strength. A high level of confidence is provided by benchmark analysis and independent evaluations. Derived from text

N93-26920*# Babcock and Wilcox Co., Lynchburg, VA. Space Systems Engineering.
BABCOCK AND WILCOX ASSESSMENT OF THE PRATT AND WHITNEY XNR2000
Kurt O. Westerman, Stephen W. Scoles, R. R. Jensen, J. R. Rodes, and M. W. Ales *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 1 1993 p 217-245 (For primary document see N93-26908 10-20)
Avail: CASI HC A03/MF A04

Babcock & Wilcox performed four subtasks related to the assessment of the Pratt & Whitney XNR2000 nuclear reactor as follows: (1) cermet fuel element fabricability assessment; (2) mechanical design review of the reactor system; (3) neutronic analysis review; and (4) safety assessment. The results of the mechanical and physics reviews have been integrated into the reactor design. The results of the fuel and safety assessments are presented. Derived from text

N93-26921*# GenCorp Aerojet, Sacramento, CA. Propulsion Div.
NTRE EXTENDED LIFE FEASIBILITY ASSESSMENT Final Report
In NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 1 1993 p 246-346 Prepared in cooperation with Energopool, Moscow, Russia and Babcock and Wilcox Co., Lynchburg, VA (For primary document see N93-26908 10-20)
Avail: CASI HC A05/MF A04

Results of a feasibility analysis of a long life, reusable nuclear thermal rocket engine are presented in text and graph form. Two engine/reactor concepts are addressed: the Particle Bed Reactor (PBR) design and the Commonwealth of Independent States (CIS) concept. Engine design, integration, reliability, and safety are addressed by various members of the NTRE team from Aerojet Propulsion Division, Energopool (Russia), and Babcock & Wilcox. CASI

N93-26922*# Martin Marietta Corp., Denver, CO.
LUNAR NTR VEHICLE DESIGN AND OPERATIONS STUDY
John Hodge *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 1 1993 p 347-357 (For primary document see N93-26908 10-20)
Avail: CASI HC A03/MF A04

The results of a lunar nuclear thermal rocket (NTR) vehicle design and operations study are presented in text and graphic form. The objectives of the study were to evaluate the potential applications of a specific NTR design to past and current (First Lunar Outpost) mission profiles for piloted and cargo lunar missions, and to assess the applicability of utilizing lunar vehicle design concepts for Mars missions. CASI

N93-26923*# Science Applications International Corp., Schaumburg, IL.
MISSION DESIGN CONSIDERATIONS FOR NUCLEAR RISK MITIGATION
Mike Stancati and John Collins *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 1 1993 p 358-365 (For primary document see N93-26908 10-20)
Avail: CASI HC A02/MF A04

Strategies for the mitigation of the nuclear risk associated with two specific mission operations are discussed. These operations are the safe return of nuclear thermal propulsion reactors to earth orbit and the disposal of lunar/Mars spacecraft reactors. CASI

N93-26924*# Science Applications International Corp., Albuquerque, NM.
ENABLER 1 AND 2 ENGINE SYSTEM DESIGN MODELING AND COMPARISONS
Dennis G. Pelaccio and Christine M. Scheil *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 1 1993 p 366-389 (For primary document see N93-26908 10-20)
Avail: CASI HC A03/MF A04

Viewgraphs on Enabler 1 and 2 engine system design modeling and comparisons are presented. The objective of this research was to define a near-term solid-core nuclear thermal propulsion (NTP) engine system scaling database. A unified set of performance, weight, and size scaling data are identified and documented. Results should be useful to meet initial mission and concept design study requirements. CASI

N93-26925*# General Dynamics Corp., San Diego, CA. Space Systems Div.
CLUSTERED ENGINE STUDY
Kyle Shepard, Paul Sager, Sid Kusunoki, John Porter, Al Campion, Gunnar Mouritzan, George Glunt, George Vegter, and Rob Koontz *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 1 1993 p 390-429 (For primary document see N93-26908 10-20)
Avail: CASI HC A03/MF A04

Several topics are presented in viewgraph form which together encompass the preliminary assessment of nuclear thermal rocket engine clustering. The study objectives, schedule, flow, and groundrules are covered. This is followed by the NASA groundrules mission and our interpretation of the associated operational scenario. The NASA reference vehicle is illustrated, then the four propulsion system options are examined. Each propulsion system's preliminary design, fluid systems, operating characteristics, thrust structure, dimensions, and mass properties are detailed as well as the associated key propulsion system/vehicle interfaces. A brief series of systems analysis is also covered including: thrust vector control requirements, engine out possibilities, propulsion system failure modes, surviving system requirements, and technology requirements. An assessment of vehicle/propulsion system impacts due to the lessons learned are presented. Derived from text

N93-26926*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
NTP COMPARISON PROCESS
Robert Corban *In its* Nuclear Propulsion Technical Interchange Meeting, Volume 1 1993 p 430-437 (For primary document see N93-26908 10-20)
Avail: CASI HC A02/MF A04

The systems engineering process for the concept definition phase of the program involves requirements definition, system definition, and consistent concept definition. The requirements definition process involves obtaining a complete understanding of the system requirements based on customer needs, mission scenarios, and nuclear thermal propulsion (NTP) operating characteristics. A system functional analysis is performed to provide a comprehensive traceability and verification of top-level requirements down to detailed system specifications and provides significant insight into the measures of system effectiveness to be utilized in system evaluation. The second key element in the process is the definition of system concepts to meet the requirements. This part of the process involves engine system and reactor contractor teams to develop alternative NTP system concepts that can be evaluated against specific attributes, as well as a reference configuration against which to compare system benefits and merits. Quality function deployment (QFD), as an excellent tool within Total Quality Management (TQM) techniques, can provide the required structure and provide a link to the voice of the customer in establishing critical system qualities and their relationships. The third element of the process is the consistent performance comparison. The comparison process involves validating developed concept data and quantifying system merits through analysis, computer modeling, simulation, and rapid prototyping of the proposed high risk NTP subsystems. The maximum amount possible of quantitative data will be developed and/or validated to be utilized in the QFD evaluation matrix. If upon evaluation of a new concept or its associated subsystems determine to have substantial merit, those features will be incorporated into the reference configuration for subsequent system definition and comparison efforts. Derived from text

N93-26927*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
NUCLEAR THERMAL PROPULSION TECHNOLOGY OVERVIEW
James R. Stone *In its* Nuclear Propulsion Technical Interchange Meeting, Volume 1 1993 p 439-444 (For primary document see N93-26908 10-20)
Avail: CASI HC A02/MF A04

Viewgraphs on nuclear thermal propulsion technology overview are presented. Topics covered include non-nuclear material; instrumentation, controls, and health monitoring; turbopumps; nozzle and extension; and exhaust plume characteristics. CASI

N93-26928*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
SILICON CARBIDE SEMICONDUCTOR TECHNOLOGY FOR HIGH TEMPERATURE AND RADIATION ENVIRONMENTS **c76**
Lawrence G. Matus *In its* Nuclear Propulsion Technical Interchange Meeting, Volume 1 1993 p 445-452 (For primary document see N93-26908 10-20)
Avail: CASI HC A02/MF A04

Viewgraphs on silicon carbide semiconductor technology and its potential for enabling electronic devices to function in high temperature and high radiation environments are presented. Topics covered include silicon carbide; sublimation growth of 6H-SiC boules; SiC chemical vapor deposition reaction system; 6H silicon carbide p-n junction diode; silicon carbide MOSFET; and silicon carbide JFET radiation response. CASI

N93-26929*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
NTR PLUME MODELING **c34**
D. Byers, C.-H. Chung, and Robert M. Stubbs *In its* Nuclear Propulsion Technical Interchange Meeting, Volume 1 1993 p 453-460 (For primary document see N93-26908 10-20)
Avail: CASI HC A02/MF A04

Viewgraphs on nuclear thermal propulsion are presented. Topics covered include computational fluid dynamics (CFD) for plume analysis; molecular

fluid dynamics; molecular CFD characteristics; direct-simulation Monte-Carlo (DSMC) method; integration of DSMC and Navier-Stokes computations; and density profiles. CASI

N93-26930*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

COMPUTATIONAL FLUID DYNAMICS FOR NUCLEAR THERMAL PROPULSION **c34**

Robert M. Stubbs and Suk C. Kim *In its* Nuclear Propulsion Technical Interchange Meeting, Volume 1 1993 p 461-469 (For primary document see N93-26908 10-20)

Avail: CASI HC A02/MF A04

Viewgraphs on computational fluid dynamics (CFD) for nuclear thermal propulsion are presented. Topics covered include: hydrogen mass fraction as a function of chamber temperature; specific enthalpy of hydrogen and mole fraction of hydrogen as a function of chamber pressure; and specific impulse as a function of chamber pressure. Wall configurations of several nozzles are shown. CASI

N93-26931*# Sverdrup Technology, Inc., Brook Park, OH.

PROBABILISTIC STRUCTURAL ANALYSIS FOR NUCLEAR THERMAL PROPULSION

Ashwin Shah *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 1 1993 p 470-475 (For primary document see N93-26908 10-20)

Avail: CASI HC A02/MF A04

Viewgraphs of probabilistic structural analysis for nuclear thermal propulsion are presented. The objective of the study was to develop a methodology to certify Space Nuclear Propulsion System (SNPS) Nozzle with assured reliability. Topics covered include: advantage of probabilistic structural analysis; space nuclear propulsion system nozzle uncertainties in the random variables; SNPS nozzle natural frequency; and sensitivity of primitive variable uncertainties SNPS nozzle natural frequency and shell stress. CASI

N93-26932*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

MSFC NUCLEAR THERMAL PROPULSION TECHNOLOGY PROGRAM

Shane Swint *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 1 1993 p 476-479 (For primary document see N93-26908 10-20)

Avail: CASI HC A01/MF A04

Viewgraphs on non-nuclear materials assessment, nuclear thermal propulsion (NTP) turbomachinery technologies, and high temperature superconducting magnetic bearing technology are presented. The objective of the materials task is to identify and evaluate candidate materials for use in NTP turbomachinery and propellant feed system applications. The objective of the turbomachinery technology task is to develop and validate advanced turbomachinery technologies at the component and turbopump assembly levels. The objective of the high temperature superconductors (HTS) task is to develop and validate advanced technology for HTS passive magnetic/hydrostatic bearing. CASI

N93-26933*# Florida Univ., Gainesville. Innovative Nuclear Space Power and Propulsion Inst.

NUCLEAR GAS CORE PROPULSION RESEARCH PROGRAM

Nils J. Diaz, Edward T. Dugan, and Samim Anghaie *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 1 1993 p 480-497 (For primary document see N93-26908 10-20) (Grant NAG3-1293)

Avail: CASI HC A03/MF A04

Viewgraphs on the nuclear gas core propulsion research program are presented. The objectives of this research are to develop models and experiments, systems, and fuel elements for advanced nuclear thermal propulsion rockets. The fuel elements under investigation are suitable for gas/vapor and multiphase fuel reactors. Topics covered include advanced nuclear propulsion studies, nuclear vapor thermal rocket (NVTR) studies, and ultrahigh temperature nuclear fuels and materials studies. CASI

N93-26934*# Massachusetts Inst. of Tech., Cambridge. Dept. of Aeronautics and Astronautics.

FLOW INSTABILITY IN PARTICLE-BED NUCLEAR REACTORS **c73**

Jack L. Kerrebrock *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 1 1993 p 498-506 (For primary document see N93-26908 10-20)

Avail: CASI HC A02/MF A04

The particle-bed core offers mitigation of some of the problems of solid-core nuclear rocket reactors. Dividing the fuel elements into small spherical particles contained in a cylindrical bed through which the propellant flows radially, may reduce the thermal stress in the fuel elements, allowing higher propellant temperatures to be reached. The high temperature regions of the reactor are confined to the interior of cylindrical fuel assemblies, so most of the reactor can be relatively cool. This enables the use of structural and moderating materials which reduce the minimum critical size and mass of the reactor. One of the unresolved questions about this concept is whether the flow through the particle-bed will be well behaved, or will be subject to destructive flow instabilities. Most of the recent analyses of the stability of the particle-bed reactor have been extensions of the approach of Bussard and Delauer, where the bed is essentially treated as an array of parallel passages, so that the mass flow is continuous from inlet to outlet through any one passage. A more general three dimensional model of the bed is adopted, in which the fluid has mobility in three dimensions. Comparison of results of the earlier approach to the present one shows that the former does not accurately represent the stability at low Re. The more complete model presented should be capable of meeting this deficiency while accurately representing the effects of the cold and hot frits, and of heat conduction and radiation in the particle-bed. It can be extended to apply to the cylindrical geometry of particle-bed reactors without difficulty. From the exemplary calculations which were carried out, it can be concluded that a particle-bed without a cold frit would be subject to instability if operated at the high temperatures desired for nuclear rockets, and at power densities below about 4 megawatts per liter. Since the desired power density is about 40 megawatts per liter, it can be concluded that operation at design exit temperature but at reduced power could be hazardous for such a reactor. But the calculations also show that an appropriate cold frit could very likely cure the instability. More definite conclusions must await calculations for specific designs. Author

N93-26935*# Los Alamos National Lab., NM.

NUCLEAR PROPULSION TECHNOLOGY ADVANCED FUELS TECHNOLOGY **c73**

Walter A. Stark, Jr. *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 1 1993 p 507-519 (For primary document see N93-26908 10-20)

Avail: CASI HC A03/MF A04

Viewgraphs on advanced fuels technology are presented. Topics covered include: nuclear thermal propulsion reactor and fuel requirements; propulsion efficiency and temperature; uranium fuel compounds; melting point experiments; fabrication techniques; and sintered microspheres. CASI

N93-26936*# Los Alamos National Lab., NM. Chemical and Laser Sciences Div.

LASER DIAGNOSTICS FOR NTP FUEL CORROSION STUDIES **c36**

Paul J. Wantuck, D. P. Butt, and A. D. Sappey *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 1 1993 p 521-533 (For primary document see N93-26908 10-20)

Avail: CASI HC A03/MF A04

Viewgraphs and explanations on laser diagnostics for nuclear thermal propulsion (NTP) fuel corrosion studies are presented. Topics covered include: NTP fuels; U-Zr-C system corrosion products; planar laser-induced fluorescence (PLIF); utilization of PLIF for corrosion product characterization of nuclear thermal rocket fuel elements under test; ZrC emission spectrum; and PLIF imaging of ZrC plume. CASI

N93-26937*# Allied-Signal Corp., Morristown, NJ.

SNTP PROPELLANT MANAGEMENT SYSTEM

Tom Tippetts *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 1 1993 p 534-537 (For primary document see N93-26908 10-20)

Avail: CASI HC A01/MF A04

Viewgraphs on the following are presented: (1) space nuclear thermal propulsion (SNTP) propellant management system; (2) SNTP cycle selection; (3) NTP system components unique design constraints; (4) bleed cycle

unique design requirement for turbopump; (5) bleed cycle turbopump; (6) SNTP carbon-carbon turbine wheel; and (7) turbine development program.
CASI

N93-26938*# Phillips Lab., Edwards AFB, CA.
SPACE NUCLEAR THERMAL PROPULSION (SNTP) TESTS
George C. Allen *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 1 1993 p 538-551 Prepared in cooperation with Grumman Aerospace Corp., Bethpage, NY; Babcock and Wilcox Co., Lynchburg, VA; Brookhaven National Lab., Upton, NY; and Sandia National Lab., Albuquerque, NM (For primary document see N93-26908 10-20)
Avail: CASI HC A03/MF A04

Viewgraphs on the space nuclear thermal propulsion (SNTP) program are presented. The objective of the research is to develop advanced nuclear thermal propulsion (NTP) technology based on the particle bed reactor concept. A strong philosophical commitment exists in the industry/national laboratory team to emphasize testing in development activities. Nuclear testing currently underway to support development of SNTP technology is addressed. Derived from text

N93-26939*# Phillips Lab., Edwards AFB, CA.
SNTP ENVIRONMENTAL, SAFETY, AND HEALTH
Charles D. Harmon *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 1 1993 p 552-560 (For primary document see N93-26908 10-20)
Avail: CASI HC A02/MF A04

Viewgraphs on space nuclear thermal propulsion (SNTP) environmental, safety, and health are presented. Topics covered include: program safety policy; program safety policies; and DEIS public hearing comments. CASI

N93-26951*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
NUCLEAR PROPULSION TECHNICAL INTERCHANGE MEETING, VOLUME 2
1993 581 p Meeting held in Sandusky, OH, 20-23 Oct. 1992
(RTOP 506-49-00)
(NASA-CP-10116-Vol-2; E-7638-Vol-2; NAS 1.55:10116-Vol-2) Avail: CASI HC A25/MF A06

The purpose of the meeting was to review the work performed in fiscal year 1992 in the areas of nuclear thermal and nuclear electric propulsion technology development. These proceedings are an accumulation of the presentations provided at the meeting along with annotations provided by authors. The proceedings cover system concepts, technology development, and system modeling for nuclear thermal propulsion (NTP) and nuclear electric propulsion (NEP). The test facilities required for the development of the nuclear propulsion systems are also discussed. For individual titles, see N93-26952 through N93-26990.

N93-26952*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
OVERVIEW OF NASA/DOE/DOD INTERAGENCY MODELING TEAM AND ACTIVITIES
James T. Walton *In its* Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 562-572 (For primary document see N93-26951 10-20)
Avail: CASI HC A25/MF A06

The topics are presented in viewgraph form and include the following: background, team mission, team objective, future direction, and concluding remarks. Derived from text

N93-26953*# GenCorp Aerojet, Sacramento, CA. Propulsion Div.
ENGINE MANAGEMENT DURING NTRE START UP
Mel Bulman and Dave Saltzman *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 573-580 Prepared in cooperation with Energopool, Moscow, Russia and Babcock and Wilcox Co., Lynchburg, VA (For primary document see N93-26951 10-20)
Avail: CASI HC A25/MF A06

The topics are presented in viewgraph form and include the following: total engine system management critical to successful nuclear thermal rocket engine (NTRE) start up; NERVA type engine start windows; reactor power control; heterogeneous reactor cooling; propellant feed system dynamics; integrated NTRE start sequence; moderator cooling loop and efficient NTRE starting; analytical simulation and low risk engine development; accurate simulation through dynamic coupling of physical processes; and integrated NTRE and mission performance.
Derived from text

N93-26954*# Babcock and Wilcox Co., Lynchburg, VA.
PARTICLE BED REACTOR MODELING
Joe Sapyta, Hank Reid, and Lew Walton *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 581-607 (For primary document see N93-26951 10-20)
Avail: CASI HC A03/MF A06

The topics are presented in viewgraph form and include the following: particle bed reactor (PBR) core cross section; PBR bleed cycle; fuel and moderator flow paths; PBR modeling requirements; characteristics of PBR and nuclear thermal propulsion (NTP) modeling; challenges for PBR and NTP modeling; thermal hydraulic computer codes; capabilities for PBR/reactor application; thermal/hydralic codes; limitations; physical correlations; comparison of predicted friction factor and experimental data; frit pressure drop testing; cold frit mask factor; decay heat flow rate; startup transient simulation; and philosophy of systems modeling.
Derived from text

N93-26955*# Rockwell International Corp., Canoga Park, CA. Rocketdyne Div.
ROCKETDYNE/WESTINGHOUSE NUCLEAR THERMAL ROCKET ENGINE MODELING
James F. Glass *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 608-625 (For primary document see N93-26951 10-20)
Avail: CASI HC A03/MF A06

The topics are presented in viewgraph form and include the following: systems approach needed for nuclear thermal rocket (NTR) design optimization; generic NTR engine power balance codes; rocketdyne nuclear thermal system code; software capabilities; steady state model; NTR engine optimizer code-logic; reactor power calculation logic; sample multi-component configuration; NTR design code output; generic NTR code at Rocketdyne; Rocketdyne NTR model; and nuclear thermal rocket modeling directions.
Derived from text

N93-26956*# Pratt and Whitney Aircraft, West Palm Beach, FL.
COMPUTATIONAL MODELING OF NUCLEAR THERMAL ROCKETS
Steven D. Peery *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 626-637 (For primary document see N93-26951 10-20)
Avail: CASI HC A03/MF A06

The topics are presented in viewgraph form and include the following: rocket engine transient simulation (ROCETS) system; ROCETS performance simulations composed of integrated component models; ROCETS system architecture significant features; ROCETS engineering nuclear thermal rocket (NTR) modules; ROCETS system easily adapts Fortran engineering modules; ROCETS NTR reactor module; ROCETS NTR turbomachinery module; detailed reactor analysis; predicted reactor power profiles; turbine bypass impact on system; and ROCETS NTR engine simulation summary.
Derived from text

N93-26957*# Florida Univ., Gainesville. Innovative Nuclear Space Power and Propulsion Inst.
NTP SYSTEM SIMULATION AND DETAILED NUCLEAR ENGINE MODELING
Samim Anghaie *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 638-665 (For primary document see N93-26951 10-20)
Avail: CASI HC A03/MF A06

The topics are presented in viewgraph form and include the following: nuclear thermal propulsion (NTP) & detailed nuclear engine modeling; modeling and engineering simulation of nuclear thermal rocket systems; nuclear thermal rocket simulation system; INSPI-NTVR core axial flow profiles; INSPI-NTRV core axial flow profiles; specific impulse vs. chamber pressure; turbine pressure ratio vs. chamber pressure; NERVA core axial flow profiles; P&W XNR2000 core axial flow profiles; pump pressure rise

vs. chamber pressure; streamline of jet-induced flow in cylindrical chamber; flow pattern of a jet-induced flow in a chamber; and radiative heat transfer models. Derived from text

N93-26958*# Science Applications International Corp., Albuquerque, NM.
NUCLEAR ENGINE SYSTEM SIMULATION (NESS) VERSION 2.0
Dennis G. Pelaccio, Christine M. Scheil, and Lyman J. Petrosky (Westinghouse Electric Corp., Madison, PA.) *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 666-685 (For primary document see N93-26951 10-20)
Avail: CASI HC A03/MF A06

The topics are presented in viewgraph form and include the following; nuclear thermal propulsion (NTP) engine system analysis program development; nuclear thermal propulsion engine analysis capability requirements; team resources used to support NESS development; expanded liquid engine simulations (ELES) computer model; ELES verification examples; NESS program development evolution; past NTP ELES analysis code modifications and verifications; general NTP engine system features modeled by NESS; representative NTP expander, gas generator, and bleed engine system cycles modeled by NESS; NESS program overview; NESS program flow logic; enabler (NERVA type) nuclear thermal rocket engine; prismatic fuel elements and supports; reactor fuel and support element parameters; reactor parameters as a function of thrust level; internal shield sizing; and reactor thermal model. Derived from text

N93-26959*# Sandia National Labs., Albuquerque, NM. Nuclear Technology Dept.
SAFSIM OVERVIEW
Dean Dobranich *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 686-703 Sponsored in part by AF (For primary document see N93-26951 10-20)
Avail: CASI HC A03/MF A06

An overview of the systems analysis flow simulator (SAFSIM) computer program is provided. SAFSIM is being developed at Sandia National Laboratories and is currently funded by the Air Force Space Nuclear Thermal Propulsion (SNTP) Program. SAFSIM is a general purpose, Fortran computer program to simulate the integrated performance of complex systems involving fluid mechanics, heat transfer, and reactor dynamics. SAFSIM provides sufficient versatility to allow the engineering simulation of almost any system. SAFSIM is based on a 1-D finite element model and provides the analyst with approximate solutions to complex problems. Derived from text

N93-26960*# Brookhaven National Lab., Upton, NY.
KINETIC: A SYSTEM CODE FOR ANALYZING NUCLEAR THERMAL PROPULSION ROCKET ENGINE TRANSIENTS
Eldon Schmidt, Otto Lazareth, and Hans Ludewig *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 704-711 (For primary document see N93-26951 10-20)
Avail: CASI HC A02/MF A06

The topics are presented in viewgraph form and include the following: outline of kinetic code; a kinetic information flow diagram; kinetic neutronic equations; turbopump/nozzle algorithm; kinetic heat transfer equations per node; and test problem diagram. Derived from text

N93-26961*# Los Alamos National Lab., NM.
NEXT GENERATION SYSTEM MODELING OF NTR SYSTEMS
John J. Buksa and William J. Rider *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 712-731 (For primary document see N93-26951 10-20)
Avail: CASI HC A03/MF A06

The topics are presented in viewgraph form and include the following: nuclear thermal rocket (NTR) modeling challenges; current approaches; shortcomings of current analysis method; future needs; and present steps to these goals. Derived from text

N93-26962*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ROCKET ENGINE NUMERICAL SIMULATOR
Ken Davidian *In its* Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 732-739 (For primary document see N93-26951 10-20)
Avail: CASI HC A02/MF A06

The topics are presented in viewgraph form and include the following: a rocket engine numerical simulator (RENS) definition; objectives; justification; approach; potential applications; potential users; RENS work flowchart; RENS prototype; and conclusion. Derived from text

N93-26963*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
FACILITIES **c14**
In its Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 741-742 (For primary document see N93-26951 10-20)
Avail: CASI HC A01/MF A06

The topics are presented in viewgraph form and include the following: nuclear propulsion facility requirements; LeRC candidate facilities; and the Interagency Facility Panel (NASA, DOE, and DOD) Derived from text

N93-26964*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
PLUM BROOK FACILITIES **c14**
Robert Kozar *In its* Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 743-745 (For primary document see N93-26951 10-20)
Avail: CASI HC A01/MF A06

The topics are presented in viewgraph form and include the following: the Spacecraft Propulsion Research Research Facility (B-2); the Hydrogen Heat Transfer Facility (HHTF); the Rocket Dynamics and Control Facility (B-3); the Cryogenic Propellant Tank Site (K-Site); and the Space Power Facility (SPF). Derived from text

N93-26965*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
NEP FACILITIES (LERC) **c14**
Robert H. Vetrone *In its* Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 746-751 (For primary document see N93-26951 10-20)
Avail: CASI HC A02/MF A06

The topics are presented in viewgraph form and include the following: the Electric Propulsion Research Building (no. 16) the Electric Power Laboratory (BLDG. 301); the Tank 6 Vacuum Facility; and test facilities for electric propulsion and LeRC. Derived from text

N93-26966*# Los Alamos National Lab., NM. Field Test Div.
LOS ALAMOS STUDIES OF THE NEVADA TEST SITE FACILITIES FOR THE TESTING OF NUCLEAR ROCKETS **c14**
Michael V. Hynes *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 752-757 (For primary document see N93-26951 10-20)
Avail: CASI HC A02/MF A06

The topics are presented in viewgraph form and include the following: Nevada test site geographic location; location of NRDA facilities, area 25; assessment program plan; program goal, scope, and process -- the New Nuclear Rocket Program; nuclear rocket engine test facilities; EMAD Facility; summary of final assessment results; ETS-1 Facility; and facilities cost summary. Derived from text

N93-26967*# Idaho National Engineering Lab., Idaho Falls.
SPACE NUCLEAR THERMAL PROPULSION: EVALUATION OF PIPET AT THE INEL'S CTF **c14**
Thomas J. Hill *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 758-764 (For primary document see N93-26951 10-20)
Avail: CASI HC A02/MF A06

The scope of the report is to evaluate the feasibility and provide a rough order of magnitude (ROM) estimate of cost and schedule for testing the PIPET Reactors in the Contained Test Facility (CTF). The topics are presented in viewgraph form and include the following: PIPET Facility requirements; existing CTF Facilities; CTF background; CTR report assumptions; ETS size information; ETS component arrangement evaluation; proposed ETS configuration; the cost evaluation results; and CTF schedule. CASI

N93-26968*# Phillips Lab., Edwards AFB, CA.
SPACE NUCLEAR THERMAL PROPULSION (SNTP) AIR FORCE FACILITY **c14**
David F. Beck *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 765-776 Prepared in cooperation with Grumman Aerospace Corp., Bethpage, NY; Babcock and Wilcox Co., Lynchburg, VA; Brookhaven National Lab., Upton, NY; and Sandia National Labs., Albuquerque, NM (For primary document see N93-26951 10-20)
Avail: CASI HC A03/MF A06

The Space Nuclear Thermal Propulsion (SNTP) Program is an initiative within the US Air Force to acquire and validate advanced technologies that could be used to sustain superior capabilities in the area or space nuclear propulsion. The SNTP Program has a specific objective of demonstrating the feasibility of the particle bed reactor (PBR) concept. The term PIPET refers to a project within the SNTP Program responsible for the design, development, construction, and operation of a test reactor facility, including all support systems, that is intended to resolve program technology issues and test goals. A nuclear test facility has been designed that meets SNTP Facility requirements. The design approach taken to meet SNTP requirements has resulted in a nuclear test facility that should encompass a wide range of nuclear thermal propulsion (NTP) test requirements that may be generated within other programs. The SNTP PIPET project is actively working with DOE and NASA to assess this possibility. CASI

N93-26969*# Sandia National Labs., Albuquerque, NM. Nuclear Technology Dept.
EFFLUENT TREATMENT FOR NUCLEAR THERMAL PROPULSION GROUND TESTING **c14**
Larry R. Shipers *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 777-788 (For primary document see N93-26951 10-20)
Avail: CASI HC A03/MF A06

The objectives are to define treatment functions, review concept options, discuss PIPET effluent treatment system (ETS), and outline future activities. The topics covered include the following: reactor exhaust; effluent treatment functions; effluent treatment categories; effluent treatment options; concept evaluation; PIPETS ETS envelope; PIPET effluent treatment concept; and future activities. Derived from text

N93-26970*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
NUCLEAR ELECTRIC PROPULSION SYSTEMS OVERVIEW **c14**
Michael P. Doherty *In its* Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 790-797 (For primary document see N93-26951 10-20)
Avail: CASI HC A02/MF S06

The topics are presented in viewgraph form and include the following: nuclear propulsion background; schedule for the nuclear electric propulsion (NEP) project; NEP for the Space Exploration Initiative; NEP on-going systems tasks; 20KWe mission/system study; and agenda. CASI

N93-26971*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
THE 20 kWe NEP SYSTEM STUDIES
Jeffrey A. George *In its* Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 798-806 (For primary document see N93-26951 10-20)
Avail: CASI HC A02/MF A06

The topics are presented in viewgraph form and include the following: initial study groundrules; power system groundrules/assumptions; power technologies assessment; prototype SP-100 system specific mass; custom SP-100 system specific mass; radiator packaging limits; Brayton system specific mass and radiator area; thermoelectric specific mass and radiator area; specific mass for prototype vs. custom SP-100-based systems; system packaging limits on power level (kWe); and a conceptual nuclear electric propulsion (NEP) science mission spacecraft design. CASI

N93-26972*# Science Applications International Corp., Schaumburg, IL.
CONCEPTUAL DEFINITION OF A 50-100 kWe NEP SYSTEM FOR PLANETARY SCIENCE MISSIONS
Alan Friedlander *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 807-810 (For primary document see N93-26951 10-20)
Avail: CASI HC A01/MF A06

The Phase 1 objective of this project is to assess the applicability of a common Nuclear Electric Propulsion (NEP) flight system of the 50-100 kWe power class to meet the advanced transportation requirements of a suite of planetary science (robotic) missions, accounting for differences in mission-specific payloads and delivery requirements. The candidate missions are as follows: (1) Comet Nucleus Sample Return; (2) Multiple Mainbelt Asteroid Rendezvous; (3) Jupiter Grand Tour (Galilean satellites and magnetosphere); (4) Uranus Orbiter/Probe (atmospheric entry and landers); (5) Neptune Orbiter/Probe (atmospheric entry and landers); and (6) Pluto-Charon Orbiter/Lander. The discussion is presented in vugraph form. Author (revised)

N93-26973*# Oak Ridge National Lab., TN. Engineering Physics and Mathematics Div.
SCOPING CALCULATIONS OF POWER SOURCES FOR NEP
Felix C. Difilippo *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 811-820 (For primary document see N93-26951 10-20)
(Contract DE-AC05-84OR-21400)
Avail: CASI HC A02/MF A06

Three Nuclear Electric Propulsion (NEP) systems are evaluated in the context of the two following criteria: (1) power levels (P)--10-50 Mw; and (2) core life (D)--2-10 yrs. The three types of reactors are as follows: (1) high temperature gas-cooled reactors of the NERVA derivative type; (2) lithium-cooled advanced fuel pin--one-phase flow; and (3) lithium-cooled Cermet--one-phase flow. The discussion is presented in vugraph form. Author (revised)

N93-26974*# Rockwell International Corp., Canoga Park, CA. Rocketdyne Div.
NEP POWER SUBSYSTEM MODELING
Richard B. Harty *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 821-838 (For primary document see N93-26951 10-20)
Avail: CASI HC A03/MF A06

The Nuclear Electric Propulsion (NEP) system optimization code consists of a master module and various submodules. Each of the submodules represents a subsystem within the total NEP power system. The master module sends commands and input data to each of the submodules and receives output data back. Rocketdyne was responsible for preparing submodules for the power conversion (both K-Rankine and Brayton), heat rejection, and power management and distribution. Author (revised)

N93-26975*# Science Applications International Corp., Schaumburg, IL.
NEP PROCESSING, OPERATIONS, AND DISPOSAL Final Report
Mike Stancati *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 839-921 Prepared in cooperation with Martin Marietta Corp., Bethesda, MD (For primary document see N93-26951 10-20)
(Contract NAS3-25809)
Avail: CASI HC A04/MF A06

Several recent studies by ASAO/NPO staff members at LeRC and by other organizations have highlighted the potential benefits of using Nuclear Electric Propulsion (NEP) as the primary transportation means for some of the proposed missions of the Space Exploration Initiative. These include the potential to reduce initial mass in orbit and Mars transit time. Modular NEP configurations also introduce fully redundant main propulsion to Mars flight systems adding several abort or fall back options not otherwise available. Recent studies have also identified mission operations, such as on orbital assembly, refurbishment, and reactor disposal, as important discriminators for propulsion system evaluation. This study is intended to identify and assess 'end-to-end' operational issues associated with using NEP for transporting crews and cargo between Earth and Mars. We also include some consideration of lunar cargo transfer as well.
Author (revised)

N93-26976*# Science Applications International Corp., New York, NY.
NUCLEAR ELECTRIC PROPULSION OPERATIONAL RELIABILITY AND CREW SAFETY STUDY: NEP SYSTEMS/MODELING REPORT
James Karns *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 922-990 (For primary document see N93-26951 10-20)
(Contract NAS3-25809)
Avail: CASI HC A04/MF A06

The objective of this study was to establish the initial quantitative reliability bounds for nuclear electric propulsion systems in a manned Mars mission required to ensure crew safety and mission success. Finding the reliability bounds involves balancing top-down (mission driven) requirements and bottom-up (technology driven) capabilities. In seeking this balance we hope to accomplish the following: (1) provide design insights into the achievability of the baseline design in terms of reliability requirements, given the existing technology base; (2) suggest alternative design approaches which might enhance reliability and crew safety; and (3) indicate what technology areas require significant research and development to achieve the reliability objectives. Author (revised)

N93-26977*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
NEP TECHNOLOGY: FY 1992 MILESTONES (NASA LERC)
Jim Sovey *In its* Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 992-999 (For primary document see N93-26951 10-20)
Avail: CASI HC A02/MF A06

A discussion of Nuclear Electric Propulsion (NEP) thrusters and facilities is presented in vugraph form. The NEP thrusters are discussed in the context of the following three items: (1) establishing a 100 H test capability for 100-kW magnetoplasmadynamic (MPD) thrusters; (2) demonstrating a lightweight 20-kW krypton ion thruster; and (3) the optimization of the design of low-mass power processor transformers. The primary accomplishment at NEP facilities was the completion of the Electric Propulsion Laboratory's (EPL's) tank 5 cryopump upgrade. CASI

N93-26978*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
POWER MANAGEMENT AND DISTRIBUTION TECHNOLOGY
John Ellis Dickman *In its* Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 1000-1008 (For primary document see N93-26951 10-20)
Avail: CASI HC A02/MF A06

Power management and distribution (PMAD) technology is discussed in the context of developing working systems for a piloted Mars nuclear electric propulsion (NEP) vehicle. The discussion is presented in vugraph form. The following topics are covered: applications and systems definitions; high performance components; the Civilian Space Technology Initiative (CSTI) high capacity power program; fiber optic sensors for power diagnostics; high temperature power electronics; 200 C baseplate electronics; high temperature component characterization; a high temperature coaxial transformer; and a silicon carbide mosfet. CASI

N93-26979*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
RADIATOR TECHNOLOGY
Albert J. Juhasz *In its* Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 1009-1026 (For primary document see N93-26951 10-20)
Avail: CASI HC A03/MF A06

Radiator technology is discussed in the context of the Civilian Space Technology Initiative's (CSTI's) high capacity power-thermal management project. The CSTI project is a subset of a project to develop a piloted Mars nuclear electric propulsion (NEP) vehicle. The following topics are presented in vugraph form: advanced radiator concepts; heat pipe codes and testing; composite materials; radiator design and integration; and surface morphology. CASI

N93-26980*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
JPL NUCLEAR ELECTRIC PROPULSION TASK
Tom Pivirotto, Keith Goodfellow, and Jay Polk *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 1027-1040 (For primary document see N93-26951 10-20)
Avail: CASI HC A03/MF A06

The development of lithium magnetoplasmadynamic (MPD) thrusters at JPL is discussed. The following topics are presented in vugraph form: mercury vapor mass flow control; porous tungsten vaporizer and housing; the lithium vaporizer experiment; a dry box for handling solid lithium; MPD thruster electrode modeling; engine lifetime definitions; cathode failure modeling; cathode erosion modeling; cathode thermal modeling; near cathode plasma model regions; cathode work function modeling; anode work function modeling; and radiation-cooled anodes. CASI

N93-26981*# Los Alamos National Lab., NM.
LOS ALAMOS RESEARCH IN NOZZLE BASED COAXIAL PLASMA THRUSTERS
Kurt F. Schoenberg *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 1041-1052 (For primary document see N93-26951 10-20)
Avail: CASI HC A03/MF A06

The following topics are discussed: MMWe electric propulsion; MMWe thruster development; and coaxial thruster performance. The discussion is presented in vugraph form. CASI

N93-26982*# Lawrence Livermore National Lab., CA.
ELECTRON CYCLOTRON THRUSTER NEW MODELING RESULTS PREPARATION FOR INITIAL EXPERIMENTS
E. Bickford Hooper *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 1053-1061 (For primary document see N93-26951 10-20)
Avail: CASI HC A02/MF A06

The following topics are discussed: a whistler-based electron cyclotron resonance heating (ECRH) thruster; cross-field coupling in the helicon approximation; wave propagation; wave structure; plasma density; wave absorption; the electron distribution function; isothermal and adiabatic plasma flow; ECRH thruster modeling; a PIC code model; electron temperature; electron energy; and initial experimental tests. The discussion is presented in vugraph form. CASI

N93-26983*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
THE 20 kWe NEP FLIGHT SYSTEM
Jim Gilland *In its* Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 1063-1077 Prepared in cooperation with Sverdrup Technology, Inc., Brook Park, OH (For primary document see N93-26951 10-20)
Avail: CASI HC A03/MF A06

A low-power, near-term nuclear electric propulsion (NEP) system was proposed as a useful interim system for near-term space exploration. Although the ultimate goal of a 100 kWe class, low specific mass for planetary exploration remains, application of the technologies that are currently mature to earlier missions of interest has grown at the higher levels of NASA. In response to this interest, a study of low-power system and mission options was initiated, with the Nuclear Propulsion Office serving to coordinate system activities. A nominal 20 kWe system using Brayton power conversion was selected by the joint NASA/DOE Space Nuclear Power and Propulsion team; however, other power levels and system options will be considered. NASA's Office of Space Science and Applications has expressed interest in exploiting NEP's mission capabilities, both in the near-term and for more difficult, later missions. Technologies considered mature for this type of system are the SP-100 reactor, Brayton dynamic power conversion, and 30 cm ion thrusters, all of which have extensive ground demonstration backgrounds. Author (revised)

N93-26984*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
THE 100-500 kWe NEP SYSTEMS
Jeffrey A. George *In its* Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 1078-1084 (For primary document see N93-26951 10-20)
Avail: CASI HC A02/MF A06

Systems technology for nuclear electric propulsion (NEP) vehicles is

discussed. The following topics are discussed: the SP-100 reactor; dynamic power conversion; heat rejection; and krypton ion thrusters. The discussion is presented in vugraph form. CASI

N93-26985*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

NUCLEAR ELECTRIC PROPULSION OPTIONS FOR PILOTED MARS MISSIONS

Jeffrey A. George *In its* Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 1085-1094 (For primary document see N93-26951 10-20)

Avail: CASI HC A02/MF A06

Three nuclear electric propulsion (NEP) systems are discussed. The three systems are as follows: a system based on current SP-100 technology; a potassium Rankine-cycle based power conversion system, and an argon ion thruster system. The system will be researched for implementation in several possible vehicle configurations. The following are among the possible Mars vehicle configurations: a piloted 15 MWe multi-reactor vehicle; a piloted 10 MWe vehicle with ECCV; a piloted 10 MWe modular vehicle; piloted 10 and 15 MWe vehicles with ECCV and MEV; a piloted 5 MWe vehicle with ECCV; a 5 MWe cargo vehicle with 2 MEV's; and a 2.5 MWe vehicle with MEV. CASI

N93-26986*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

NEP SYSTEMS MODEL

Jim Gilland and Jeffrey A. George *In its* Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 1095-1098 Prepared in cooperation with Sverdrup Technology, Inc., Brook Park, OH (For primary document see N93-26951 10-20)

Avail: CASI HC A01/MF A06

Various aspects of nuclear electric propulsion (NEP) systems analysis and modeling are discussed. The following specific topics are covered: (1) systems analysis challenges; (2) goals for NEP systems analysis; (3) the Nuclear Propulsion Office approach; and (4) NEP subsystem model development. The discussion is presented in vugraph form. CASI

N93-26987*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

NEP SYSTEMS MODEL

Jeffrey A. George *In its* Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 1098-1102 (For primary document see N93-26951 10-20)

Avail: CASI HC A01/MF A06

A new nuclear electric propulsion (NEP) systems analysis code is discussed. The new code is modular and consists of a driver code and various subsystem models. The code models five different subsystems: (1) reactor/shield; (2) power conversion; (3) heat rejection; (4) power management and distribution (PMAD); and (5) thrusters. The code optimizes for the following design criteria: minimum mass; minimum radiator area; and low mass/low area. The code also optimizes the following parameters: separation distance; temperature ratio; pressure ratio; and transmission frequency. The discussion is presented in vugraph form. CASI

N93-26988*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

THRUSTER MODELS FOR NEP SYSTEM ANALYSIS

Jim Gilland *In its* Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 1103-1118 Prepared in cooperation with Sverdrup Technology, Inc., Brook Park, OH (For primary document see N93-26951 10-20)

Avail: CASI HC A03/MF A06

There are currently no thruster modeling codes that can be integrated with power system codes for full propulsion system modeling. Most existing thruster models were written from a 'stand alone' viewpoint, assuming the user is performing analyses on thruster performance alone. The goal of the present modeling effort is to develop thruster codes that model performance and scaling as a function of mission and system inputs, rather than in terms of more elemental physical parameters. System level parameters of interest are as follows: performance, such as specific impulse and efficency; terminal characteristics, such as voltage or current; and mass. Specific impulse and efficiency couple with mission analyses, while terminal characteristics allow integration with power systems. Additional information on lifetime and operation may be required for detailed designs. Author (revised)

N93-26989*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

INNOVATIVE ELECTRIC PROPULSION THRUSTER MODELING

Robert H. Frisbee *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 1119-1133 (For primary document see N93-26951 10-20)

Avail: CASI HC A03/MF A06

The objective of this program is to model and evaluate advanced nuclear electric propulsion (NEP) system concepts as an aid to the performance of NEP mission benefits studies. The two primary goals are as follows: (1) provide scaling relationships for mass, power, and efficiency, as functions of Isp, propellant type, and other important quantities. The discussion is presented in vugraph form. CASI

N93-26990*# Argonne National Lab., IL. Engineering Physics Div.

GPS SYSTEM SIMULATION METHODOLOGY

Thomas F. Ewing *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 2 1993 p 1134-1142 (For primary document see N93-26951 10-20)

Avail: CASI HC A02/MF A06

The following topics are presented: background; Global Positioning System (GPS) methodology overview; the graphical user interface (GUI); current models; application to space nuclear power/propulsion; and interfacing requirements. The discussion is presented in vugraph form. CASI

N93-27022*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

RELIABILITY STUDIES OF INTEGRATED MODULAR ENGINE SYSTEM DESIGNS

Terry L. Hardy and Douglas C. Rapp (Sverdrup Technology, Inc., Cleveland, OH.) Jun. 1993 19 p Proposed for presentation at the 29th Joint Propulsion Conference and Exhibit, Monterey, CA, 28-30 Jun. 1992; sponsored by AIAA, SAE, ASME, and ASEE

(RTOP 468-02-11)

(NASA-TM-106178; E-7774; NAS 1.15:106178; AIAA Paper 93-1886)

Avail: CASI HC A03/MF A01

A study was performed to evaluate the reliability of Integrated Modular Engine (IME) concepts. Comparisons were made between networked IME systems and non-networked discrete systems using expander cycle configurations. Both redundant and non-redundant systems were analyzed. Binomial approximation and Markov analysis techniques were employed to evaluate total system reliability. In addition, Failure Modes and Effects Analyses (FMEA), Preliminary Hazard Analyses (PHA), and Fault Tree Analysis (FTA) were performed to allow detailed evaluation of the IME concept. A discussion of these system reliability concepts is also presented. Author

N93-27039*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

SOLAR ARRAY ELECTRICAL PERFORMANCE ASSESSMENT FOR SPACE STATION FREEDOM

Bryan K. Smith and Holly Brisco (Lockheed Missiles and Space Co., Sunnyvale, CA.) May 1993 13 p Presented at the Aerospace Design Conference, Irvine, CA, 16-19 Feb. 1993; cosponsored by AIAA, AHS, and ASEE Previously announced in IAA as A93-30956

(RTOP 474-46-10)

(NASA-TM-106161; E-7748; NAS 1.15:106161) Avail: CASI HC A03/MF A01

Electrical power for Space Station Freedom will be generated by large Photovoltaic arrays with a beginning of life power requirement of 30.8 kW per array. The solar arrays will operate in a Low Earth Orbit (LEO) over a design life of fifteen years. This paper provides an analysis of the predicted solar array electrical performance over the design life and presents a summary of supporting analysis and test data for the assigned model parameters and performance loss factors. Each model parameter and loss factor is assessed based upon program requirements, component analysis, and test data to date. A description of the LMSC performance model,

future test plans, and predicted performance ranges are also given.
Author (revised)

N93-27060*# Sverdrup Technology, Inc., Brook Park, OH.
AN ANALYTICAL OPTIMIZATION OF ELECTRIC PROPULSION ORBIT TRANSFER VEHICLES Final Report
Steven R. Oleson May 1993 10 p
(Contract NAS3-25266; RTOP 506-49-11)
(NASA-CR-191129; E-7841; NAS 1.26:191129) Avail: CASI HC A02/MF A01

Due to the electric propulsion's inherent propellant mass savings over chemical propulsion, electric propulsion orbit transfer vehicles (EPOTV's) are highly efficient mode of orbit transfer. When selecting an electric propulsion device (ion, MPD, or arcjet) and propellant for a particular mission, it is preferable to use quick, analytical system optimization methods instead of time intensive numerical integration methods. It is also of interest to determine each thruster's optimal operating characteristics for a specific mission. Analytical expressions are derived which determine the optimal specific impulse (Isp) for each type of electric thruster to maximize payload fraction for a desired thrusting time. These expressions take into account the variation of thruster efficiency with specific impulse. Verification of the method is made with representative electric propulsion values on a LEO-to-GEO mission. Application of the method to specific missions is discussed. Author

N93-27134# Johns Hopkins Univ., Columbia, MD. Chemical Propulsion Information Agency.
THE 29TH JANNAF COMBUSTION SUBCOMMITTEE MEETING, VOLUME 1
Mary T. Gannaway, ed. Oct. 1992 444 p Meeting held in Hampton, VA, 19-23 Oct. 1992; sponsored by the Joint NASA, Army, Navy, Air Force Interagency Propulsion Committee
(Contract N00014-91-C-0001)
(CPIA-Publ-593-Vol-1) Avail: CPIA, 10630 Little Patuxent Pkwy., Suite 202, Columbia, MD 21044-3200 HC

This volume, the first of five volumes, is a collection of 36 unclassified/unlimited papers which were presented at the 29th Joint Army-Navy-NASA-Air Force (JANNAF) Combustion Subcommittee Meeting, 19-23 October 1992, at NASA Langley Research Center, Hampton, Virginia. Specific subjects discussed include gun propellants, interior ballistics, electrothermal-chemical guns and liquid guns. For individual titles, see N93-27135 through N93-27140.

N93-27135*# Washington Univ., Seattle. Aerospace and Energetics Research.
HIGH SPATIAL RESOLUTION MEASUREMENTS IN A SINGLE STAGE RAM ACCELERATOR
J. B. Hinkey, E. A. Burnham, and A. P. Bruckner *In* JHU, The 29th JANNAF Combustion Subcommittee Meeting, Volume 1 Oct. 1992 p 189-210 (For primary document see N93-27134 10-20)
(Contracts NAG1-1288; F49620-92-J-0375; DAAL03-92-G-0100)
Avail: CPIA, 10630 Little Patuxent Pkwy., Suite 202, Columbia, MD 21044-3200 HC

High spatial resolution experimental tube wall pressure measurements of ram accelerator gas dynamic phenomena are presented in this paper. The ram accelerator is a ramjet-in-tube device which operates in a manner similar to that of a conventional ramjet. The projectile resembles the centerbody of a ramjet and travels supersonically through a tube filled with a combustible gaseous mixture, with the tube acting as the outer cowling. Pressure data are recorded as the projectile passes by sensors mounted in the tube wall at various locations along the tube. Utilization of special highly instrumented sections of tube has allowed the recording of gas dynamic phenomena with high resolution. High spatial resolution tube wall pressure data from the three regimes of propulsion studied to date (subdetonative, transdetonative, and superdetonative) in a single stage gas mixture are presented and reveal the three-dimensional character of the flow field induced by projectile fins and the canting of the fins and the canting of the projectile body relative to the tube wall. Also presented for comparison to the experimental data are calculations made with an inviscid, three-dimensional CFD code. The knowledge gained from these experiments and simulations is useful in understanding the underlying nature of ram accelerator propulsive regimes, as well as assisting in the validation of three-dimensional CFD coded which model unsteady, chemically reactive flows. Author

N93-27136*# Washington Univ., Seattle. Aerospace and Energetics Research.
INVESTIGATION OF STARTING TRANSIENTS IN THE THERMALLY CHOKED RAM ACCELERATOR
E. A. Burnham, J. B. Hinkey, and A. P. Bruckner *In* JHU, The 29th JANNAF Combustion Subcommittee Meeting, Volume 1 Oct. 1992 p 211-234 (For primary document see N93-27134 10-20)
(Contracts NAG1-1288; F49620-92-J-0375; DAAL03-92-G-0100)
Avail: CPIA, 10630 Little Patuxent Pkwy., Suite 202, Columbia, MD 21044-3200 HC

An experimental investigation of the starting transients of the thermally choked ram accelerator is presented in this paper. Construction of a highly instrumented tube section and instrumentation inserts provide high resolution experimental pressure, luminosity, and electromagnetic data of the starting transients. Data obtained prior to and following the entrance diaphragm show detailed development of shock systems in both combustible and inert mixtures. With an evacuated launch tube, starting the diffuser is possible at any Mach number above the Kantrowitz Mach number. The detrimental effects and possible solutions of higher launch tube pressures and excessive obturator leakage (blow-by) are discussed. Ignition of a combustible mixture is demonstrated with both perforated and solid obturators. The relative advantages and disadvantages of each are discussed. Data obtained from these starting experiments enhance the understanding of the ram accelerator, as well as assist in the validation of unsteady, chemically reacting CFD codes. Author

N93-27137# Army Research Lab., Aberdeen Proving Ground, MD. Propulsion and Flight Div.
EXPERIMENTAL DEMONSTRATION OF A 120-mm RAM ACCELERATOR
David L. Kruczynski *In* JHU, The 29th JANNAF Combustion Subcommittee Meeting, Volume 1 Oct. 1992 p 235-244 (For primary document see N93-27134 10-20)
Avail: CPIA, 10630 Little Patuxent Pkwy., Suite 202, Columbia, MD 21044-3200 HC

Ram acceleration is an emerging propulsion technology in which a projectile similar in shape to the centerbody of a ramjet aircraft engine is injected at high speed into a tube filled with a combustible gaseous mixture. As the projectile moves into the tube, under supersonic conditions, shocks occur on and around the projectile. If the gases are then ignited either by the energy in the shock system or an external mechanism, the combustion around or behind the projectile can be self-sustaining. The net effect is to generate a localized high pressure region around and/or behind the projectile which produces acceleration. Work at the University of Washington, Seattle, has demonstrated velocities in excess of 2.6 km/s in 38-mm caliber, while theory predicts velocities above 7 km/s may be obtainable. A program was initiated at the Weapons Technology Directorate of the US Army Research Laboratory (formerly Ballistic Research Laboratory) to examine the scaling potential of ram acceleration for use as a high velocity, high mass, (i.e., high kinetic energy) launcher. Data from initial gas mixing tests and first firings through a 120-mm bore diameter ram accelerator with both inert and live fuel gases are presented. Initial comparisons with ram accelerators of smaller scale are made. Discussions of scaling parameters as currently understood will be presented. Author (revised)

N93-27138# Army Research Lab., Aberdeen Proving Ground, MD. Propulsion and Flight Div.
NAVIER-STOKES SIMULATION OF TRANSIENT FLUID DYNAMICS AND INITIATION OF COMBUSTION IN THE RAM ACCELERATOR
Michael J. Nusca *In* JHU, The 29th JANNAF Combustion Subcommittee Meeting, Volume 1 Oct. 1992 p 245-261 (For primary document see N93-27134 10-20)
Avail: CPIA, 10630 Little Patuxent Pkwy., Suite 202, Columbia, MD 21044-3200 HC

Computational fluid dynamics solutions of the full Navier-Stokes equations have been used to numerically simulate the reacting in-bore flowfield for the ram accelerator projectile propulsion system. In this system, a projectile is injected at supersonic velocity into a stationary tube filled

with a pressurized mixture of hydrocarbon, oxidizer, and inert gases. The natural shock system generated around the projectile in conjunction with a pusher sabot initiates combustion of the mixture. Combustion takes place on the projectile surface and in the wake. This energy release process which travels with the projectile also generates high pressures and imparts thrust to the projectile. Whereas numerical solution of governing equations utilizing finite-rate chemical kinetics has been reported previously, this paper investigates the utility of the equilibrium chemistry assumption for this flowfield. Results show that these simulations can numerically reproduce several modes of accelerator operation both using a perforated and a solid pusher sabot for the projectile, and including those modes at and beyond the Chapman-Jouget detonation velocity of the mixture.
Author (revised)

N93-27139# Science Applications International Corp., Fort Washington, PA. Propulsion Fluid Dynamics Div.
TRANSIENT SIMULATION OF RAM ACCELERATOR FLOWFIELDS
N. Sinha, B. J. York, S. M. Dash, R. Drabczuk (Wright Lab., Eglin AFB, FL.), and G. E. Rolader (Science Applications International Corp., Shalimar, FL.) *In* JHU, The 29th JANNAF Combustion Subcommittee Meeting, Volume 1 Oct. 1992 p 263-278 (For primary document see N93-27134 10-20)
(Contract F08630-91-C-0001)
Avail: CPIA, 10630 Little Patuxent Pkwy., Suite 202, Columbia, MD 21044-3200 HC

This paper describes the development of an advanced computational fluid dynamic (CFD) simulation capability in support of the U.S. Air Force Armament Directorate's ram accelerator research initiative. The state-of-the-art CRAFT computer code has been specialized for high fidelity, transient ram accelerator simulations via inclusion of generalized dynamic gridding, solution adaptive grid clustering, high pressure thermochemistry, etc. Selected ram accelerator simulations are presented which serve to exhibit the CRAFT code's capabilities and identify some of the principal research/design issues. Author

N93-27140# Naval Research Lab., Washington, DC.
NUMERICAL SIMULATIONS OF REACTIVE FLOWS IN RAM ACCELERATORS
C. Li, A. M. Landsberg, K. Kailasanath, E. S. Oran, and J. P. Boris *In* JHU, The 29th JANNAF Combustion Subcommittee Meeting, Volume 1 Oct. 1992 p 279-288 (For primary document see N93-27134 10-20)
Avail: CPIA, 10630 Little Patuxent Pkwy., Suite 202, Columbia, MD 21044-3200 HC

Reactive flows around accelerating projectiles in ram accelerators are numerically simulated using a newly developed code for time-dependent flows in noninertial frames. Two different modes of operations, the thermally choked mode and the superdetonative mode have been investigated. The simulations show that, in both modes, a significant acceleration (up to 10(exp 5) g) can be achieved with projectiles of different shapes in various hydrogen-oxygen-nitrogen mixtures. However, the flow field is highly transient and the thrust on the projectile is unsteady. In the thermally choked mode, the unsteadiness is caused by the rapid acceleration of the projectile and large-scale, vortical flow structures generated in or near the recirculation region behind the projectile. In the superdetonative mode, the unsteadiness is mainly caused by the accelerating projectile. Author (revised)

N93-27146*# Alabama Univ., Huntsville.
STUDY OF BASIC PHYSICAL PROCESSES IN LIQUID AND SOLID ROCKET PROPULSION Final Report, 14 Dec. 1992 - 13 May 1993
Joseph W. Monroe 14 May 1993 6 p
(Contract NAS8-38609)
(NASA-CR-192550; NAS 1.26:192550; UAH-5-33125) Avail: CASI HC A02/MF A01

A process model was developed to assess the suitability of new/modified technologies and subsystems for application to commercial launch vehicles. Suitability is measured in terms of cost, safety, and environmental impact. Cost is related to recurring production and operational cost per flight, amortization of non-recurring development costs, 'effective' cost of difference in payload capability, and the cost of unreliability. The process is also applicable for assessing technologies and subsystems for application to other launch vehicles. The process will enable a comprehensive systems engineering approach to assess the potential of technologies and subsystems for launch vehicle applications and to provide documentation of the results for application to technology planning for the future. Author (revised)

N93-27157*# Lockheed Missiles and Space Co., Iuka, MS. Aerojet ASRM Div.
ASRM TEST REPORT: AUTOCLAVE CURE PROCESS DEVELOPMENT Final Report
D. L. Nachbar and Suzanne Mitchell 1 May 1992 276 p
(Contract NAS8-37800)
(NASA-CR-192535; NAS 1.26:192535; TM04514-03) Avail: CASI HC A13/MF A03

ASRM insulated segments will be autoclave cured following insulation pre-form installation and strip wind operations. Following competitive bidding, Aerojet ASRM Division (AAD) Purchase Order 100142 was awarded to American Fuel Cell and Coated Fabrics Company, Inc. (Amfuel), Magnolia, AR, for subcontracted insulation autoclave cure process development. Autoclave cure process development test requirements were included in Task 3 of TM05514, Manufacturing Process Development Specification for Integrated Insulation Characterization and Stripwind Process Development. The test objective was to establish autoclave cure process parameters for ASRM insulated segments. Six tasks were completed to: (1) evaluate cure parameters that control acceptable vulcanization of ASRM Kevlar-filled EPDM insulation material; (2) identify first and second order impact parameters on the autoclave cure process; and (3) evaluate insulation material flow-out characteristics to support pre-form configuration design. Derived from text

N93-27240*# Alabama Univ., Huntsville. Research Inst.
SHUTTLE PRCS PLUME CONTAMINATION ANALYSIS FOR ASTRO-2 MISSION Final Technical Report, 24 Feb. - 30 Apr. 1993
Francis C. Wang and Cindy Greene 30 Apr. 1993 39 p
(NASA Order H-18063-D)
(NASA-CR-193101; NAS 1.26:193101; UAH-5-33173) Avail: CASI HC A03/MF A01

The Astro-2 mission scheduled for Jan. 1995 flight is co-manifested with the Spartan experiment. The Astro instrument array consists of several telescopes operating in the UV spectrum. To obtain the desired 300 observations with the telescope array in a shorter time than the Astro-1 mission, it will be necessary to use the primary reaction control system (PRCS) rather than just the Vernier reaction control system. The high mass flow rate of the PRCS engines cause considerable concern about contamination due to PRCS plume return flux. Performance of these instruments depends heavily on the environment they encounter. The ability of the optical system to detect a remote signal depends not only on the intensity of the incoming signal, but also on the ensuing transmission loss through the optical train of the instrument. Performance of these instruments is thus dependent on the properties of the optical surface and the medium through which it propagates. The on-orbit contamination environment will have a strong influence on the performance of these instruments. The finding of a two-month study of the molecular contamination environment of the Astro-2 instruments due to PRCS thruster plumes during the planned Astro-2 mission are summarized. Author (revised)

N93-27251*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
DESIGN VERIFICATION TEST MATRIX DEVELOPMENT FOR THE STME THRUST CHAMBER ASSEMBLY
Carol E. Dexter, Sandra K. Elam, and David L. Sparks Jun. 1993 40 p
(NASA-TM-108406; NAS 1.15:108406) Avail: CASI HC A03/MF A01

This report presents the results of the test matrix development for design verification at the component level for the National Launch System (NLS) space transportation main engine (STME) thrust chamber assembly (TCA) components including the following: injector, combustion chamber, and nozzle. A systematic approach was used in the development of the minimum recommended TCA matrix resulting in a minimum number of hardware units and a minimum number of hot fire tests. Author (revised)

N93-27532*# GenCorp Aerojet, Sacramento, CA.
LOX/HYDROCARBON ROCKET ENGINE ANALYTICAL DESIGN METHODOLOGY DEVELOPMENT AND VALIDATION. VOLUME 2: APPENDICES Final Report
Karen E. Niiya, Richard E. Walker, Jerry L. Pieper, and Thong V. Nguyen

Cleveland, OH NASA May 1993 192 p
(Contract NAS3-25556; RTOP 590-21-21)
(NASA-CR-191059-Vol-2; E-7827-Vol-2; NAS 1.26:191059-Vol-2) Avail: CASI HC A09/MF A02

This final report includes a discussion of the work accomplished during the period from Dec. 1988 through Nov. 1991. The objective of the program was to assemble existing performance and combustion stability models into a usable design methodology capable of designing and analyzing high-performance and stable LOX/hydrocarbon booster engines. The methodology was then used to design a validation engine. The capabilities and validity of the methodology were demonstrated using this engine in an extensive hot fire test program. The engine used LOX/RP-1 propellants and was tested over a range of mixture ratios, chamber pressures, and acoustic damping device configurations. This volume contains time domain and frequency domain stability plots which indicate the pressure perturbation amplitudes and frequencies from approximately 30 tests of a 50K thrust rocket engine using LOX/RP-1 propellants over a range of chamber pressures from 240 to 1750 psia with mixture ratios of from 1.2 to 7.5. The data is from test configurations which used both bitune and monotune acoustic cavities and from tests with no acoustic cavities. The engine had a length of 14 inches and a contraction ratio of 2.0 using a 7.68 inch diameter injector. The data was taken from both stable and unstable tests. All combustion instabilities were spontaneous in the first tangential mode. Although stability bombs were used and generated overpressures of approximately 20 percent, no tests were driven unstable by the bombs. The stability instrumentation included six high-frequency Kistler transducers in the combustion chamber, a high-frequency Kistler transducer in each propellant manifold, and tri-axial accelerometers. Performance data is presented, both characteristic velocity efficiencies and energy release efficiencies, for those tests of sufficient duration to record steady state values. Author (revised)

N93-27535*# Aerojet-General Corp., Sacramento, CA.
LOX/HYDROCARBON ROCKET ENGINE ANALYTICAL DESIGN METHODOLOGY DEVELOPMENT AND VALIDATION. VOLUME 1: EXECUTIVE SUMMARY AND TECHNICAL NARRATIVE
Jerry L. Pieper and Richard E. Walker Cleveland, OH NASA May 1993 191 p
(Contract NAS3-25556; RTOP 590-21-21)
(NASA-CR-191058-Vol-1; E-7828-Vol-1; NAS 1.26:191058-Vol-1) Avail: CASI HC A09/MF A02

During the past three decades, an enormous amount of resources were expended in the design and development of Liquid Oxygen/Hydrocarbon and Hydrogen (LOX/HC and LOX/H2) rocket engines. A significant portion of these resources were used to develop and demonstrate the performance and combustion stability for each new engine. During these efforts, many analytical and empirical models were developed that characterize design parameters and combustion processes that influence performance and stability. Many of these models are suitable as design tools, but they have not been assembled into an industry-wide usable analytical design methodology. The objective of this program was to assemble existing performance and combustion stability models into a usable methodology capable of producing high performing and stable LOX/hydrocarbon and LOX/hydrogen propellant booster engines. Author (revised)

N93-28324*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
ROCKET ENGINE NOZZLE ATTENUATOR Patent Application
David A. Lewis, inventor (to NASA) (Pratt and Whitney Aircraft, West Palm Beach, FL.) 27 Jan. 1993 11 p
(NASA-Case-MFS-28739-1; NAS 1.71:MFS-28739-1;
US-Patent-Appl-SN-010034) Avail: CASI HC A03/MF A01

The function of a rocket engine nozzle is to expand the hot engine exhaust gases down to ambient pressure, transforming thermal energy to directed kinetic energy in order to produce thrust. Considering nozzle design, there is an optimum nozzle shape and length, the bell-shaped or contour nozzle. The reason for this specific contour is that the nozzle must be designed in such a manner that the expansion shock waves emanating from the nozzle throat region coincide, and thus diminish the compression effects accompanying the reorientation of flow in the center region of the expansion section. A rocket nozzle must absorb a variety of loads caused by such shocks due to thermal expansion and contraction, as well as shocks from sudden pressurization at startup, and flight accelerations. A rocket engine nozzle is provided which is capable of attenuating nozzle vibrations generated therein during use. The nozzle includes an annular closed chamber surrounding the nozzle adjacent to its gas exhaust end. Within the chamber is a dense but unrestricted particulate mass capable of undergoing frictional movement within the chamber. NASA

N93-28325*# Rockwell International Corp., Canoga Park, CA. Rocketdyne Div.
ADVANCED TRANSPORTATION SYSTEM STUDIES. ALTERNATE PROPULSION SUBSYSTEM CONCEPTS: PROPULSION DATABASE Interim Report
Daniel Levack Apr. 1993 293 p
(Contract NAS8-39210)
(NASA-CR-192545; NAS 1.26:192545; DCN-1-1-PP-02147; TA3-0309a)
Avail: CASI HC A13/MF A03

The Advanced Transportation System Studies alternate propulsion subsystem concepts propulsion database interim report is presented. The objective of the database development task is to produce a propulsion database which is easy to use and modify while also being comprehensive in the level of detail available. The database is to be available on the Macintosh computer system. The task is to extend across all three years of the contract. Consequently, a significant fraction of the effort in this first year of the task was devoted to the development of the database structure to ensure a robust base for the following years' efforts. Nonetheless, significant point design propulsion system descriptions and parametric models were also produced. Each of the two propulsion databases, parametric propulsion database and propulsion system database, are described. The descriptions include a user's guide to each code, write-ups for models used, and sample output. The parametric database has models for LOX/H2 and LOX/RP liquid engines, solid rocket boosters using three different propellants, a hybrid rocket booster, and a NERVA derived nuclear thermal rocket engine. Derived from text

N93-28424*# National Aeronautics and Space Administration. Pasadena Office, CA.
THREE-GRID ACCELERATOR SYSTEM FOR AN ION PROPULSION ENGINE Patent Application
John R. Brophy, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) 20 May 1993 15 p
(Contract NAS7-918)
(NASA-Case-NPO-18391-1-CU; NAS 1.71:NPO-18391-1-CU;
US-Patent-Appl-SN-066829) Avail: CASI HC A03/MF A01

Apparatus for an ion engine comprises a three-grid accelerator system with the decelerator grid biased negative of the beam plasma. This arrangement substantially reduces the charge-exchange ion current reaching the accelerator grid at high tank pressures, which minimizes erosion of the accelerator grid due to charge-exchange ion sputtering, known to be the major accelerator grid wear mechanism. An improved method for life testing ion engines is also provided using the disclosed apparatus. In addition, the invention can also be applied in materials processing. NASA

N93-27188 Prins Maurits Lab. TNO, Rijswijk (Netherlands).
GAS GENERATOR IGNITER PERFORMANCE AT EXTREMELY LOW TEMPERATURES
G. M. H. J. L. Gadiot *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 178-184 (For primary document see N93-27166 10-01)
Copyright Avail: Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel

N93-27215 Rafael Armament Development Authority, Haifa (Israel).
EROSION SENSITIVITY OF GRAPHITIC NOZZLES FOR SOLID-PROPELLANT ROCKET MOTORS
T. Shoham *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 404-411 (For primary document see N93-27166 10-01)
Copyright Avail: Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel

N93-27216 Technion - Israel Inst. of Tech., Haifa. Faculty of Aerospace Engineering.
EVALUATION OF LOW POWER AUGMENTED HYDRAZINE THRUSTERS
Ilan Hadar and Alon Gany *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 412-419 (For primary document see N93-27166 10-01)
Copyright Avail: Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel

N93-27798*# Boeing Aerospace and Electronics Co., Huntsville, AL.
PROPULSION NEEDS FOR LUNAR/MARS MISSIONS
Gordon R. Woodcock *In* NASA, Washington, Technology for Space Station Evolution. Volume 3: EVA/Manned Systems/Fluid Management System 1990 p 241-260 (For primary document see N93-27786 10-18)
Avail: CASI HC A03/MF A03; 1 functional color page

N93-27811*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
ADVANCED MODULAR POWER SUPPLIES FOR SPACE STATION FREEDOM
S. Krauthamer, M. D. Gangal, and R. C. Detwiler *In* NASA, Washington, Technology for Space Station Evolution. Volume 4: Power Systems/Propulsion/Robotics 1990 p 151-199 (For primary document see N93-27803 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

N93-27812*# Little (Arthur D.), Inc., Cambridge, MA.
POWER BEAMING OPTIONS FOR THE SPACE STATION
Peter E. Glaser *In* NASA, Washington, Technology for Space Station Evolution. Volume 4: Power Systems/Propulsion/Robotics 1990 p 201-212 (For primary document see N93-27803 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

N93-27814*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
INTEGRATED POWER AND ATTITUDE CONTROL SYSTEM (IPACS) TECHNOLOGY DEVELOPMENTS
David B. Eisenhaure (SatCon Technology Corp., Cambridge, MA.), Robert Bechtel, Richard Hockney (SatCon Technology Corp., Cambridge, MA.), Ron Oglevie, and Mitch Olszewski (Oak Ridge National Lab., TN.) *In* NASA, Washington, Technology for Space Station Evolution. Volume 4: Power Systems/Propulsion/Robotics 1990 p 241-273 (For primary document see N93-27803 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

N93-27816*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
AUTOMATION OF SPACE STATION MODULE POWER MANAGEMENT AND DISTRIBUTION SYSTEM
Robert Bechtel, Dave Weeks, and Bryan Walls *In* NASA, Washington, Technology for Space Station Evolution. Volume 4: Power Systems/Propulsion/Robotics 1990 p 291-327 (For primary document see N93-27803 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

N93-27817*# National Aeronautics and Space Administration, Washington, DC.
SPACE STATION PROPULSION SYSTEM
J. Henderson *In its* Technology for Space Station Evolution. Volume 4: Power Systems/Propulsion/Robotics 1990 p 331-357 (For primary document see N93-27803 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

N93-27818*# National Aeronautics and Space Administration, Washington, DC.
SPACE STATION PROPULSION INTEGRATED PROPULSION TEST ARTICLE
J. Henderson *In its* Technology for Space Station Evolution. Volume 4: Power Systems/Propulsion/Robotics 1990 p 361-369 (For primary document see N93-27803 10-18)
Avail: CASI HC A02/MF A04; 1 functional color page

N93-27819*# Hamilton Standard, Windsor Locks, CT.
SPE (TM) ELECTROLYZERS FOR SPACE PROPULSION
E. M. Shane *In* NASA, Washington, Technology for Space Station Evolution. Volume 4: Power Systems/Propulsion/Robotics 1990 p 371-397 (For primary document see N93-27803 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

N93-27863*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
PROPULSION TECHNOLOGY DISCIPLINE
Lee W. Jones *In* NASA, Washington, Technology for Space Station Evolution. Executive Summary and Overview 1990 p 179-196 (For primary document see N93-27854 10-18)
Avail: CASI HC A03/MF A03; 1 functional color page

N93-27963*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
AN EVOLUTION STRATEGY FOR LUNAR NUCLEAR SURFACE POWER
Lee S. Mason *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 14 p (For primary document see N93-27956 10-91)
Avail: CASI HC A03/MF A03

N93-27964*# National Aeronautics and Space Administration, Washington, DC.
EARTH TO SPACE POWER BEAMING: A NEW NASA TECHNOLOGY INITIATIVE Abstract only
John D. G. Rather *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 1 p (For primary document see N93-27956 10-91)
Avail: CASI HC A01/MF A03

N93-27966*# Boeing Defense and Space Group, Huntsville, AL.
ELECTRICAL POWER INTEGRATION FOR LUNAR OPERATIONS
Gordon Woodcock *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 15 p (For primary document see N93-27956 10-91)
Avail: CASI HC A03/MF A03

N93-27987*# New York Univ., New York.
CHOICE OF ANTENNA GEOMETRY FOR MICROWAVE POWER TRANSMISSION FROM SOLAR POWER SATELLITES
Seth D. Potter *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 9 p (For primary document see N93-27956 10-91)
Avail: CASI HC A02/MF A03

23 CHEMISTRY AND MATERIALS (GENERAL)

N93-27003*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
A KINETIC AND EQUILIBRIUM ANALYSIS OF SILICON CARBIDE CHEMICAL VAPOR DEPOSITION ON MONOFILAMENTS
S. A. Gokoglu and M. A. Kuczmarski May 1993 10 p Presented at the 12th International Conference on Chemical Vapor Deposition (CVD 12), Honolulu, HI, 16-21 May 1993; sponsored by Electrochemical Society (RTOP 505-63-5A)
(NASA-TM-106137; E-7818; NAS 1.15:106137) Avail: CASI HC A02/MF A01

Chemical kinetics of atmospheric pressure silicon carbide (SiC) chemical vapor deposition (CVD) from dilute silane and propane source gases in hydrogen is numerically analyzed in a cylindrical upflow reactor designed for CVD on monofilaments. The chemical composition of the SiC deposit is assessed both from the calculated total fluxes of carbon and silicon and from chemical equilibrium considerations for the prevailing temperatures and species concentrations at and along the filament surface. The effects of gas and surface chemistry on the evolution of major gas phase species are considered in the analysis. Author (revised)

N93-27266*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

LOW EARTH ORBITAL ATOMIC OXYGEN ENVIRONMENTAL SIMULATION FACILITY FOR SPACE MATERIALS EVALUATION

Curtis R. Stidham (Sverdrup Technology, Inc., Brook Park, OH.), Bruce A. Banks, Thomas J. Stueber (Sverdrup Technology, Inc., Brook Park, OH.), Joyce A. Dever, Sharon K. Rutledge, and Eric J. Bruckner (Cleveland State Univ., OH.) May 1993 15 p Presented at the 38th International SAMPE Symposium and Exhibition, Anaheim, CA, 10-13 May 1993; sponsored by the Society for the Advancement of Material and Process Engineering

(RTOP 474-46-10)

(NASA-TM-106128; E-7797; NAS 1.15:106128) Avail: CASI HC A03/MF A01

Simulation of low Earth orbit atomic oxygen for accelerated exposure in ground-based facilities is necessary for the durability evaluation of space power system component materials for Space Station Freedom (SSF) and future missions. A facility developed at the National Aeronautics and Space Administrations's (NASA) Lewis Research Center provides accelerated rates of exposure to a directed or scattered oxygen beam, vacuum ultraviolet (VUV) radiation, and offers in-situ optical characterization. The facility utilizes an electron-cyclotron resonance (ECR) plasma source to generate a low energy oxygen beam. Total hemispherical spectral reflectance of samples can be measured in situ over the wavelength range of 250 to 2500 nm. Deuterium lamps provide VUV radiation intensity levels in the 115 to 200 nm range of three to five equivalent suns. Retarding potential analyses show distributed ion energies below 30 electron volts (eV) for the operating conditions most suited for high flux, low energy testing. Peak ion energies are below the sputter threshold energy (approximately 30 eV) of the protective coatings on polymers that are evaluated in the facility, thus allowing long duration exposure without sputter erosion. Neutral species are expected to be at thermal energies of approximately .04 eV to .1 eV. The maximum effective flux level based on polyimide Kapton mass loss is 4.4 x 10 exp 6 atoms/((sq. cm)*s), thus providing a highly accelerated testing capability. Author (revised)

24 COMPOSITE MATERIALS

Includes physical, chemical, and mechanical properties of laminates and other composite materials.

For ceramic materials see *27 Nonmetallic Materials.*

N93-26702*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

AN OVERVIEW OF ELEVATED TEMPERATURE DAMAGE MECHANISMS AND FATIGUE BEHAVIOR OF A UNIDIRECTIONAL SCS-6/Ti-15-3 COMPOSITE

Michael G. Castelli (Sverdrup Technology, Inc., Brook Park, OH.) and John Gayda Apr. 1993 16 p Proposed for presentation at the Tenth Biennial Conference on Reliability, Stress Analysis and Failure Prevention, Albuquerque, NM, 19-22 Sep. 1993; sponsored by ASME

(RTOP 510-06-50)

(NASA-TM-106131; E-7729; NAS 1.15:106131) Avail: CASI HC A03/MF A01

The fatigue behavior of a unidirectionally reinforced titanium matrix composite (TMC), SiC/Ti-15-3, was thoroughly characterized to support life prediction modeling of advanced TMC disks designed for gas turbine engine applications. The results of this coupon-level experimental investigation are reviewed. On a stress basis, the isothermal fatigue behavior of the (0 deg) TMC revealed significant improvements over the unreinforced matrix. In contrast, the (90 deg) TMC exhibited degraded properties and lives for similar comparisons. This was attributed to the weak fiber/matrix interfacial bond. Encasing the (0 deg) TMC with a Ti-15-3 case did not affect isothermal fatigue lives at higher strain levels. However, at lower strain levels, rapid initiation and propagation of large fatigue cracks in the case degraded the fatigue lives. Thermomechanical fatigue (TMF) lives were significantly reduced for the (0 deg) TMC when compared to isothermal lives. At high strains, in-phase TMF produced extremely short lives. This degradation was attributed to fiber overload failures brought about by stress relaxation in the matrix. At low strains, out-of-phase TMF conditions became life limiting. Environment-assisted surface cracking was found to accelerate fatigue failure. This produced extensive matrix damage with minimal fiber damage. For the (90 deg) TMC, TMF conditions did not promote an additional degradation in cyclic life beyond that observed under isothermal conditions. Author (revised)

N93-26704*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

FIBER SHAPE EFFECTS ON METAL MATRIX COMPOSITE BEHAVIOR

H. C. Brown (Sverdrup Technology, Inc., Brook Park, OH.), H.-J. Lee, and C. C. Chamis Mar. 1992 33 p Presented at the 37th International SAMPE Symposium and Exhibition, Anaheim, CA, 9-12 Mar. 1992; sponsored by the Society for the Advancement of Materials and Process Engineering

(RTOP 510-01-50)

(NASA-TM-106067; E-7672; NAS 1.15:106067) Avail: CASI HC A03/MF A01

The effects of different fiber shapes on the behavior of a SiC/Ti-15 metal matrix composite is computationally simulated. A three-dimensional finite element model consisting of a group of nine unidirectional fibers is used in the analysis. The model is employed to represent five different fiber shapes: a circle, an ellipse, a kidney, and two different cross shapes. The distribution of microstresses and the composite material properties, such as moduli, coefficients of thermal expansion, and Poisson's ratios, are obtained from the finite element analysis for the various fiber shapes. Comparisons of these results are used to determine the sensitivity of the composite behavior to the different fiber shapes and assess their potential benefits. No clear benefits result from different fiber shapes though there are some increases/decreases in isolated properties. Author

N93-26705*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

DYNAMIC CHARACTERISTICS OF SPECIALTY COMPOSITE STRUCTURES WITH EMBEDDED DAMPING LAYERS

D. A. Saravanos (Ohio Aerospace Inst., Brook Park.) and C. C. Chamis May 1993 32 p Presented at the Symposium on Vibroacoustic Characterization of Materials and Structures, Anaheim, CA, 8-12 Nov. 1992; sponsored by ASME

(Contract NCC3-208/4; RTOP 510-02-12)

(NASA-TM-106165; E-7863; NAS 1.15:106165) Avail: CASI HC A03/MF A01

Damping mechanics for simulating the damped dynamic characteristics in specialty composite structures with compliant interlaminar damping layers are presented. Finite-element based mechanics incorporating a discrete layer (or layer-wise) laminate damping theory are utilized to represent general laminate configurations in terms of lay-up and fiber orientation angles, cross-sectional thickness, shape, and boundary conditions. Evaluations of the method with exact solutions and experimental data illustrate the accuracy of the method. Additional applications investigate the potential for significant damping enhancement in angle-ply composite laminates with cocured interlaminar damping layers. Author

N93-26944# Michigan Univ., Ann Arbor. Dept. of Materials Science and Engineering.

FUNDAMENTAL ALLOY DESIGN OF OXIDE CERAMICS AND THEIR COMPOSITES

I. W. Chen 1992 38 p

(Contract DE-FG02-87ER-45302)

(DE93-010249; DOE/ER-45302/6) Avail: CASI HC A03/MF A01

The main research was on microstructural development of oxide ceramics. Projects were completed and the publications given. Abstracts are given on: Reactive CeO2 powders by homogeneous precipitation, SiC whisker-reinforced lithium aluminosilicate composite, solute drag on grain boundary in ionic solids (space charge effect), in-situ alumina/aluminate platelet composites, exaggerated texture and grain growth of superplastic silicon nitride (SiAlON), hot extrusion of ceramics, control of grain boundary pinning in Al2O3/ZrO2 composites with Ce(3+)/Ce(4+) doping, superplastic forming of ceramic composites, computer simulation of final stage sintering (model, kinetics, microstructure, effect of initial pore size), development of superplastic structural ceramics, and superplastic flow of two-phase ceramics containing rigid inclusions (zirconia/mullite composites). A proposed research program is outlined: materials, solute drag, densification and coarsening, and grain boundary electrical behavior. DOE

N93-27062*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

MODELING FATIGUE CRACK GROWTH IN CROSS PLY TITANIUM MATRIX COMPOSITES

J. G. Bakuckas, Jr. and W. S. Johnson May 1993 36 p Presented at the ASTM Fifth Symposium on Composite Materials: Fatigue and Fracture, Atlanta, GA, 4-6 May 1993 Sponsored by NASA. Washington

(RTOP 763-23-45-85)

(NASA-TM-108988; NAS 1.15:108988) Avail: CASI HC A03/MF A01

In this study, the fatigue crack growth behavior of fiber bridging matrix cracks in cross-ply SCS-6/Ti-15-3 and SCS-6/Timetal-21S laminates containing center holes was investigated. Experimental observations revealed that matrix cracking was far more extensive and wide spread in the SCS-6/Ti-15-3 laminates compared to that in the SCS-6/Timetal-21S laminates. In addition, the fatigue life of the SCS-6/Ti-15-3 laminates was significantly longer than that of the SCS-6/Timetal-21S laminates. The matrix cracking observed in both material systems was analyzed using a fiber bridging (FB) model which was formulated using the boundary correction factors and weight functions for center hole specimen configurations. A frictional shear stress is assumed in the FB model and was used as a curve fitting parameter to model matrix crack growth data. The higher frictional shear stresses calculated in the SCS-6/Timetal-21S laminates resulted in lower stress intensity factors in the matrix and higher axial stresses in the fibers compared to those in the SCS-6/Ti-15-3 laminates at the same applied stress levels. Author (revised)

N93-27082*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

PROBABILISTIC SIZING OF LAMINATES WITH UNCERTAINTIES

A. R. Shah (Sverdrup Technology, Inc., Brook Park, OH.), D. G. Liaw (Sverdrup Technology, Inc., Brook Park, OH.), and C. C. Chamis May 1993 19 p Presented at the 24th International SAMPE Technical Conference, Toronto, Ontario, 20-22 Oct. 1992; sponsored by Society for the Advancement of Materials and Process Engineering

(RTOP 510-02-12)

(NASA-TM-106145; E-7826; NAS 1.15:106145) Avail: CASI HC A03/MF A01

A reliability based design methodology for laminate sizing and configuration for a special case of composite structures is described. The methodology combines probabilistic composite mechanics with probabilistic structural analysis. The uncertainties of constituent materials (fiber and matrix) to predict macroscopic behavior are simulated using probabilistic theory. Uncertainties in the degradation of composite material properties are included in this design methodology. A multi-factor interaction equation is used to evaluate load and environment dependent degradation of the composite material properties at the micromechanics level. The methodology is integrated into a computer code IPACS (Integrated Probabilistic Assessment of Composite Structures). Versatility of this design approach is demonstrated by performing a multi-level probabilistic analysis to size the laminates for design structural reliability of random type structures. The results show that laminate configurations can be selected to improve the structural reliability from three failures in 1000, to no failures in one million. Results also show that the laminates with the highest reliability are the least sensitive to the loading conditions. Author

N93-27086*# Virginia Univ., Charlottesville.

AN ANALYTICAL/NUMERICAL CORRELATION STUDY OF THE MULTIPLE CONCENTRIC CYLINDER MODEL FOR THE THERMOPLASTIC RESPONSE OF METAL MATRIX COMPOSITES Final Report

Marek-Jerzy Pindera, Robert S. Salzar, and Todd O. Williams May 1993 34 p

(Contract NAS3-26571; RTOP 510-01-50)

(NASA-CR-191142; E-7856; NAS 1.26:191142) Avail: CASI HC A03/MF A01

The utility of a recently developed analytical micromechanics model for the response of metal matrix composites under thermal loading is illustrated by comparison with the results generated using the finite-element approach. The model is based on the concentric cylinder assemblage consisting of an arbitrary number of elastic or elastoplastic sublayers with isotropic or orthotropic, temperature-dependent properties. The elastoplastic boundary-value problem of an arbitrarily layered concentric cylinder is solved using the local/global stiffness matrix formulation (originally developed for elastic layered media) and Mendelson's iterative technique of successive elastic solutions. These features of the model facilitate efficient investigation of the effects of various microstructural details, such as functionally graded architectures of interfacial layers, on the evolution of residual stresses during cool down. The available closed-form expressions for the field variables can readily be incorporated into an optimization algorithm in order to efficiently identify optimal configurations of graded interfaces for given applications. Comparison of residual stress distributions after cool down generated using finite-element analysis and the present micromechanics model for four composite systems with substantially different temperature-dependent elastic, plastic, and thermal properties illustrates the efficacy of the developed analytical scheme. Author

N93-27092*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

PROBABILISTIC ASSESSMENT OF COMPOSITE STRUCTURES

C. C. Chamis and Michael C. Shiao (Sverdrup Technology, Inc., Brook Park, OH.) Feb. 1993 20 p

(RTOP 510-02-12)

(NASA-TM-106024; E-7587; NAS 1.15:106024) Avail: CASI HC A03/MF A01

A methodology and attendant computer code were developed and are used to computationally simulate the uncertain behavior of composite structures. The uncertain behavior includes buckling loads, stress concentration factors, displacements, stress/strain, etc., which are the consequences of the inherent uncertainties (scatter) in the primitive (independent random) variables (constituent, ply, laminate, and structural) that describe the composite structures. The computer code is IPACS (Integrated Probabilistic Assessment of Composite Structures). IPACS can simulate both composite mechanics and composite structural behavior. Application to probabilistic composite mechanics is illustrated by its use to evaluate the uncertainties in the major Poisson's ratio and in laminate stiffness and strength. IPACS' application to probabilistic structural analysis is illustrated by its used to evaluate the uncertainties in the buckling of a composite plate, the stress concentration factor in a composite panel, and the vertical displacement and ply stress in a composite aircraft wing segment. IPACS' application to probabilistic design is illustrated by its use to assess the thin composite shell (pipe). Author (revised)

N93-27129*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

RADIAL BASIS FUNCTION NETWORK LEARNS CERAMIC PROCESSING AND PREDICTS RELATED STRENGTH AND DENSITY

Krzysztof J. Cios (Toledo Univ., OH.), George Y. Baaklini, Alex Vary, and Robert E. Tjia (Toledo Univ., OH.) May 1993 20 p

(RTOP 505-63-1M)

(NASA-TM-106048; E-7795; NAS 1.15:106048) Avail: CASI HC A03/MF A01

Radial basis function (RBF) neural networks were trained using the data from 273 Si3N4 modulus of rupture (MOR) bars which were tested at room temperature and 135 MOR bars which were tested at 1370 C. Milling time, sintering time, and sintering gas pressure were the processing parameters used as the input features. Flexural strength and density were the outputs by which the RBF networks were assessed. The 'nodes-at-data-points' method was used to set the hidden layer centers and output layer training used the gradient descent method. The RBF network predicted strength with an average error of less than 12 percent and density with an average error of less than 2 percent. Further, the RBF network demonstrated a potential for optimizing and accelerating the development and processing of ceramic materials. Author (revised)

N93-27141*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

INFLUENCE OF TRANSVERSE-SHEAR AND LARGE-DEFORMATION EFFECTS ON THE LOW-SPEED IMPACT RESPONSE OF LAMINATED COMPOSITE PLATES

Damodar R. Ambur, James H. Starnes, Jr., and Chunchu B. Prasad (Analytical Services and Materials, Inc., Hampton, VA.) Apr. 1993 32 p

(RTOP 505-63-50-08)

(NASA-TM-107753; NAS 1.15:107753) Avail: CASI HC A03/MF A01

An analytical procedure is presented for determining the transient

response of simply supported, rectangular laminated composite plates subjected to impact loads from airgun-propelled or dropped-weight impactors. A first-order shear-deformation theory is included in the analysis to represent properly any local short-wave-length transient bending response. The impact force is modeled as a locally distributed load with a cosine-cosine distribution. A double Fourier series expansion and the Timoshenko small-increment method are used to determine the contact force, out-of-plane deflections, and in-plane strains and stresses at any plate location due to an impact force at any plate location. The results of experimental and analytical studies are compared for quasi-isotropic laminates. The results indicate that using the appropriate local force distribution for the locally loaded area and including transverse-shear-deformation effects in the laminated plate response analysis are important. The applicability of the present analytical procedure based on small deformation theory is investigated by comparing analytical and experimental results for combinations of quasi-isotropic laminate thicknesses and impact energy levels. The results of this study indicate that large-deformation effects influence the response of both 24- and 32-ply laminated plates, and that a geometrically nonlinear analysis is required for predicting the response accurately.

Author (revised)

N93-27270*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

FUZZY SETS PREDICT FLEXURAL STRENGTH AND DENSITY OF SILICON NITRIDE CERAMICS

Krzysztof J. Cios (Toledo Univ., OH.), Leszek M. Sztandera (Toledo Univ., OH.), George Y. Baaklini, and Alex Vary May 1993 23 p

(RTOP 506-01-50)

(NASA-TM-106049; E-7794; NAS 1.15:106049) Avail: CASI HC A03/MF A01

In this work, we utilize fuzzy sets theory to evaluate and make predictions of flexural strength and density of NASA 6Y silicon nitride ceramic. Processing variables of milling time, sintering time, and sintering nitrogen pressure are used as an input to the fuzzy system. Flexural strength and density are the output parameters of the system. Data from 273 Si3N4 modulus of rupture bars tested at room temperature and 135 bars tested at 1370 C are used in this study. Generalized mean operator and Hamming distance are utilized to build the fuzzy predictive model. The maximum test error for density does not exceed 3.3 percent, and for flexural strength 7.1 percent, as compared with the errors of 1.72 percent and 11.34 percent obtained by using neural networks, respectively. These results demonstrate that fuzzy sets theory can be incorporated into the process of designing materials, such as ceramics, especially for assessing more complex relationships between the processing variables and parameters, like strength, which are governed by randomness of manufacturing processes.

Author (revised)

N93-27653# Union Carbide Corp., Parma, OH. Carbon Products Div.

EXPLORATION OF MULTILAYER CONCEPTS FOR OXIDATION PROTECTION OF CARBON-CARBON COMPOSITES Final Report

R. V. Sara Feb. 1993 74 p

(Contract N00014-90-C-0057)

(AD-A262380) Avail: CASI HC A04/MF A01

The development of multilayer coating concepts for oxidation protection of carbon-carbon composites is the subject of this work. Property requirements of constituents for candidate systems are presented. In this regard, erosion, carbon and oxygen diffusion, chemical stability, bonding, compliancy and thermal expansion are discussed and the impact they have on coating effectiveness is correlated with experimental coating results. Of particular interest is the ability to manipulate crack origin, propagation direction and stoppage by giving judicious consideration to layer CTE and compliance. This capability increases the opportunity to fabricate multilayer coatings with crack-free oxygen diffusion layers. Chemical vapor deposited SiC on compliant substrates was essentially crack-free and, therefore, provided excellent oxidation protection. DTIC

N93-27667# Space Exploration Association, Cedarville, OH.

JOINING CARBON COMPOSITE FINS TO TITANIUM HEAT PIPES Final Report, 8 Jun. 1992 - 15 Feb. 1993

Elliot B. Kennel, Arnold H. Deutchman, Robert L. Partyka, Anatoliy Yastrebkov, and Yuri Nikolayev 15 Feb. 1993 41 p

(Contract DASG60-92-C-0137)

(AD-A261970) Avail: CASI HC A03/MF A01

An experimental effort was conducted to metallize a high thermal conductivity carbon carbon composite using ion beam enhanced deposition, and then to join it to titanium by diffusion bonding. Basic feasibility of the concept was demonstrated. DTIC

N93-27672# Aerospace Corp., El Segundo, CA. Technology Operations.

PROCESSING EFFECTS ON THE MECHANICAL BEHAVIOR OF POLYARYLACETYLENE-DERIVED CARBON-CARBON COMPOSITES

Rafael J. Zaldivar, Gerald S. Rellick, and J.-M. Yang 30 Jun. 1992 32 p

(Contract F04701-88-C-0089)

(AD-A262102; TR-0091(6935-06)-5; SMC-TR-93-08) Avail: CASI HC A03/MF A01

Polyarylacetylene (PAA), a highly cross-linked aromatic polymer, has been investigated as a matrix precursor for carbon-carbon (C/C) composites. PAA has advantages over other state-of-the-art phenolic resin systems because of its ease of processability, higher char yield, and lower pyrolysis shrinkage. Use of PAA as a matrix precursor therefore reduces the number of redensification cycles, a critical processing advancement that reduces the cost and improves the reliability of C/C composites. The microstructural development in composites of T-50 fibers and PAA was examined at various processing stages using x-ray diffraction and scanning electron microscopy. Composites heat-treated at 1100 and 1800 deg were amorphous. Upon heat treatment to 2400 deg C, localized graphitization was evident. The mechanical properties and fracture behavior of these composites were then correlated with the microstructural changes occurring during heat treatment: PAA-derived C/C composites heat-treated to 1100 deg C exhibited low strength (468 MPa) and had brittle-type fractures; samples heat-treated to higher temperatures had greater strengths (1.516 GPa), owing to such mechanisms as crack deflection and blunting. These strengthening mechanisms were attributed to the localized, well-aligned matrix microstructure that is evident in many thermosetting-resin-derived carbon matrix composites. DTIC

N93-27676# Wright Lab., Wright-Patterson AFB, OH.

THERMOMECHANICAL FATIGUE BEHAVIOR OF A SILICON CARBIDE FIBER-REINFORCED CALCIUM ALUMINOSILICATE GLASS-CERAMIC MATRIX COMPOSITE Final Report, Aug. 1990 - Dec. 1991

L. M. Butkus Aug. 1992 131 p

(AF Proj. 2302)

(AD-A262265; WL-TR-92-4071) Avail: CASI HC A07/MF A02

Isothermal fatigue and in-phase thermomechanical fatigue (TMF) tests were performed on a unidirectional, continuous-fiber, Nicalon - reinforced calcium aluminosilicate glass-ceramic composite ((0)16, SiC/CAS-II). Monotonic tensile tests were performed; at 1100 deg. C and 100 MPa/sec to determine the material's ultimate strength and proportional limit. Isothermal fatigue tests at 100 deg. C employed two loading profiles, a triangular waveform with ramp times of 60 seconds, and a similar profile with a superimposed 60 second hold time at maximum stress. All fatigue tests used a maximum stress of 100 MPa, R = 0.1. TMF loading profiles were identical to the isothermal loading profiles, but the temperature was cycled between 500 and 1100 deg. C. All fatigued specimens reached run out (1000 cycles) and were tested in tension at 1100 deg. C immediately following the fatigue tests. Residual modulus, residual strength, cyclic stress-strain modulus, and strain accumulation were all examined as possible damage indicators. Strain accumulation allowed for the greatest distinction to be made among the type of tests performed. Fiber and matrix stress analyses and creep data for this material suggest that matrix creep is the primary source of damage for the fatigue loading histories investigated.

DTIC

N93-28113# Case Western Reserve Univ., Cleveland, OH. Dept. of Materials Science and Engineering.

NIOBIUM SILICIDES FOR HIGH TEMPERATURE APPLICATIONS Final Technical Report, 1 Aug. 1989 - 31 Dec. 1992

John J. Lewandowski 25 Jan. 1993 55 p

(Grant AF-AFOSR-0508-89)

(AD-A262334; AFOSR-93-0171TR) Avail: CASI HC A04/MF A01

The processing and properties of advanced intermetallics based on aluminide and silicide matrices have been investigated. Vacuum hot press

techniques were utilized to produce both monolithic and composite Ni3Al, NiAl, and Nb5Si3. The effects of 10 volume percent TiB2 particulate's3 on the fracture toughness of Ni 3 Al and NiAl were determined while in-situ monitoring of the fracture toughness tests was conducted with the aid of a deformation stage mounted inside a scanning electron microscope. The Nb5Si3 powders were produced via reaction synthesis followed by hot press consolidation and evaluation of fracture toughness on both the monolithic silicide as well as in-situ Nb5Si3/Nb composites. The Nb particles imparted significant toughening while both crack bridging and ductile phase toughening were observed in the in-situ fracture studies. Significant effects of loading rate on the resulting toughness was observed. DTIC

N93-28303# Los Alamos National Lab., NM.
MATERIAL SCIENCE EXPERIENCE GAINED FROM THE SPACE NUCLEAR ROCKET PROGRAM: INSULATORS
P. Wagner Jul. 1992 47 p
(Contract W-7405-eng-36)
(DE93-006301; LA-12320-MS) Avail: CASI HC A03/MF A01

Although Rover reactors are viewed as the ultimate in high-temperature operating systems, many of the materials used in these reactors (for example, support rods, control drums, and the reflector) have to be held at relatively low temperatures while the reactor operates, in order to maintain their structural integrity. Thus, the insulators needed to separate these temperature domains are crucial to the reactor's ultimate operating times and temperatures. All of the reactors that were tested used pyrolytic graphite as the primary insulator. However, it had been long planned to replace the graphite with zirconium carbide and a lengthy and intensive effort to develop the zirconium carbide insulators had been made at the time Rover was terminated. This report details research and development and the experience we gained with both these insulator materials. DOE

N93-28305# Fiber Materials, Inc., Biddeford, ME.
DEMONSTRATION AND FABRICATION OF LARGE AREA 1-3 PZT COMPOSITE PANELS Quarterly Report, 20 Aug. 1992 - 28 Feb. 1993
28 Feb. 1993 24 p
(Contract N00014-92-C-0186)
(AD-A262904; FMI-R/E-93-R-005) Avail: CASI HC A03/MF A01

Fiber Materials, Inc. has been contracted by the Office of Naval Research to develop actuator/sensor technology for smart structures through economical and automated fabrication of large area 1-3 piezocomposite advanced materials. Aspects of this effort are discussed. DTIC

N93-28383# Imperial Coll. of Science and Technology, London (England). Dept. of Mechanical Engineering.
THE ENVIRONMENTAL AND IMPACT RESISTANCE OF ADHESIVELY BONDED THERMOPLASTIC FIBRE COMPOSITES Final Report, 1 Oct. 1989 - 5 Nov. 1992
A. J. Kinloch, B. R. Blackman, and J. P. Dear 5 Nov. 1992 235 p
(Contract DAJA45-89-M-0041)
(AD-A263202) Avail: CASI HC A11/MF A03

This final report presents and discusses the results obtained in the following areas (1) Mode I and mixed mode testing of bonded joints, (2) the use of an oxygen plasma surface treatment to pretreat thermoplastic fiber composites before bonding, (3) the effect of test rate on the fracture behavior of bonded joints, and finally (4) the effects of test environment on the fracture behavior of bonded joints. DTIC

N93-28457# Oak Ridge National Lab., TN.
FABRICATION OF COMMERCIAL-SCALE FIBER-REINFORCED HOT-GAS FILTERS BY CHEMICAL VAPOR DEPOSITION
L. R. White Nov. 1992 30 p Prepared in cooperation with Minnesota Mining and Mfg. Co., St. Paul, MN
(Contract DE-AC05-84OR-21400)
(DE93-010762; ORNL/Sub-89-SB482/01) Avail: CASI HC A03/MF A01

The goal was to fabricate a filter for removing particulates from hot gases; the principal applications would be in advanced utility processes such as pressurized fluidized bed combustion or coal gasification combined cycle systems. Filters were made in two steps: make a ceramic fiber preform; and coat it with SiC by chemical vapor infiltration (CVD). The most promising construction was felt/filament wound. Light, tough ceramic composite filters can be made; reinforcement by continuous fibers is needed to avoid brittleness. Direct metal to filter contact does not damage the top which simplifies installation. However, much of the filter surface of felt/filament wound structures is closed over by the CVD coating, and the surface is rough and subject to delamination. Recommendations are given for improving the filters. DOE

N93-26695*# Environmental Research Lab., Gulf Breeze, FL.
IN-SITU MATERIALS PROCESSING SYSTEMS AND BIOREGENERATIVE LIFE SUPPORT SYSTEMS INTERRELATIONSHIPS
George V. Mignon and Robert J. Frye *In* Arizona Univ., NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 3 p (For primary document see N93-26674 10-91)
Avail: CASI HC A01/MF A03; 1 functional color page

N93-27172 Harvard Univ., Cambridge, MA. Division of Applied Sciences.
FRACTURE MICROMECHANICS OF CERAMIC COMPOSITES Abstract Only
Bernard Budiansky *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 42 (For primary document see N93-27166 10-01)
Copyright Avail: Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel

N93-27181 Israel Aircraft Industries Ltd., Tashan.
COMPOSITE LAMINATED BEND ANALYSIS AND EXPERIMENTS
I. Kressel and T. Gottesman *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 128-135 (For primary document see N93-27166 10-01)
Copyright Avail: Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel

N93-28262*# Toronto Univ., North York (Ontario). Inst. for Aerospace Studies.
OUTGASSING AND DIMENSIONAL CHANGES OF POLYMER MATRIX COMPOSITES IN SPACE
R. C. Tennyson and R. Matthews *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 877-888 Sponsored in part by Canadian Space Agency; Inst. for Space and Terrestrial Science and Ontario Centre for Materials Research (For primary document see N93-28254 10-99)
Avail: CASI HC A03/MF A04; 2 functional color pages

N93-28263*# Michigan Univ., Ann Arbor.
HIGH-TOUGHNESS GRAPHITE/EPOXY COMPOSITE MATERIAL EXPERIMENT
David K. Felbeck *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 889-903 (For primary document see N93-28254 10-99)
(Contract NAS1-17008)
Avail: CASI HC A03/MF A04; 2 functional color pages

N93-28264*# Phillips Lab., Kirtland AFB, NM. Space Environmental Interaction Branch.
LDEF FIBER-COMPOSITE MATERIALS CHARACTERIZATION
C. J. Miglionico, C. Stein, R. E. Roybal, and L. E. Murr (Texas Univ., El Paso.) *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 905-922 (For primary document see N93-28254 10-99)
(Grant NAG9-481)
Avail: CASI HC A03/MF A04; 2 functional color pages

N93-28265*# Boeing Defense and Space Group, Seattle, WA.
SPACE ENVIRONMENTAL EFFECTS ON LDEF COMPOSITES: A LEADING EDGE COATED GRAPHITE EPOXY PANEL
Pete E. George, Harry W. Dursch, and Sylvester G. Hill *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 923-939 (For primary document see N93-28254 10-99)
Avail: CASI HC A03/MF A04; 2 functional color pages

N93-28266*# Rockwell International Corp., Tulsa, OK. North American Aircraft.
THE EFFECTS OF LONG-DURATION SPACE EXPOSURE ON THE MECHANICAL PROPERTIES OF SOME CARBON-REINFORCED RESIN MATRIX COMPOSITES
Richard F. Vyhnal *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 941-955 (For primary document see N93-28254 10-99)
Avail: CASI HC A03/MF A04; 2 functional color pages

N93-28268*# Aerospace Corp., El Segundo, CA.
SURFACE ANALYSES OF COMPOSITES EXPOSED TO THE SPACE ENVIRONMENT ON LDEF
Joseph J. Mallon, Joseph C. Uht, and Carol S. Hemminger *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 963-976 (For primary document see N93-28254 10-99)
(Contract F04701-88-C-0089)
Avail: CASI HC A03/MF A04; 2 functional color pages

N93-28269*# Aerospace Corp., Los Angeles, CA. Mechanics and Materials Technology Center.
THERMAL EXPANSION BEHAVIOR OF LDEF METAL MATRIX COMPOSITES
Tuyen D. Le and Gary L. Steckel *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 977-1000 (For primary document see N93-28254 10-99)
Avail: CASI HC A03/MF A04; 2 functional color pages

25 INORGANIC AND PHYSICAL CHEMISTRY

Includes chemical analysis, e.g., chromatography; combustion theory; electrochemistry; and photochemistry.

For related information see also *77 Thermodynamics and Statistical Physics.*.

N93-26616# Pittsburgh Univ., PA. Dept. of Chemical and Petroleum Engineering.
PROBE MOLECULE STUDIES: ACTIVE SPECIES IN ALCOHOL SYNTHESIS
D. G. Blackmond, I. Wender, R. Oukaci, and J. Wang Dec. 1992 15 p
(Contract DE-FG22-90PC-90305)
(DE93-009685; DOE/PC-90305/T10) Avail: CASI HC A03/MF A01

The goal of this research is to develop a better understanding of the mechanisms of formation of alcohols and other oxygenates from syngas over supported catalysts. Probe molecules are added in situ during the reaction to help delineate reaction pathways and identify reaction intermediate species. The key of our study is to investigate how the species generated by these probe molecules interact with surface species present during oxygenate formation. The catalysts chosen for this investigation is Co/Cu/ZnO/Al2O3. Detailed motivations for studying this system as well as using CH3NO2 as the probe molecule were given in a previous report. (1) Pretreatment of a Co(0%)/Cu/ZnO/Al2O3 to be used as a base catalyst was carried out. (2) XRD experiments were carried out with the calcined and reduced samples of the 0%-Co, 5%-Co and 10%-Co catalysts. (3) Temperature programmed reduction was performed with the 0%-Co, 5%-Co and 10%-Co catalysts. (4) CO hydrogenation under the same conditions used for the 5%-Co and 10%-Co catalysts was conducted over the Co(0%)/Cu/ZnO/Al2O3 catalyst. (5) CH3NO2 addition to the steady state reaction of CO hydrogenation was conducted over both the O%-Co and the 10%-Co catalysts. DOE

N93-26619# Johns Hopkins Univ., Baltimore, MD. Dept. of Chemistry.
THEORETICAL STUDIES OF THE REACTIONS AND SPECTROSCOPY OF RADICAL SPECIES RELEVANT TO COMBUSTION REACTIONS AND DIAGNOSTICS
D. R. Yarkony Mar. 1993 10 p
(Contract DE-FG02-91ER-14189)
(DE93-010247; DOE/ER-14189/3) Avail: CASI HC A02/MF A01

This report describes work performed as part of Department of Energy grant DE-FGO2-91ER14189 during the period 16 March 1992-15 March 1993 and outlines directions for future research. During this period we have developed a new method for determining points on the surface of intersection of two potential energy surfaces corresponding to states of distinct spin-multiplicity. This approach allows any number of geometrical parameters to be fixed while the remainder are optimized to minimize the energy of the point on the crossing surface. This algorithm will significantly enhance our ability to characterize spin-forbidden electronically nonadiabatic processes. DOE

N93-26941# Lehigh Univ., Bethlehem, PA.
SELECTIVE METHANE OXIDATION OVER PROMOTED OXIDE CATALYSTS
K. Klier, R. G. Herman, Q. Sun, and J. Sarkany Jan. 1993 17 p
(Contract DE-FG21-92MC-29228)
(DE93-009768; DOE/MC-29228/3294) Avail: CASI HC A03/MF A01

Support effects on catalytic reactions, especially of highly exothermic oxidation reactions, can be very significant. Since we had shown that a MoO3/SiO2 catalyst, especially when used in a double bed configuration with a Sr/La2O3 catalyst, can selectively oxidize methane to formaldehyde, the role of the SiO2 support was investigated. Therefore, partial oxidation of methane by oxygen to form formaldehyde, carbon oxides, and C2 products (ethane and ethene) has been studied over silica catalyst supports (fumed Cabosil and Grace 636 silica gel) in the 630-780 C temperature range under ambient pressure. When relatively high gas hourly space velocities (GHSV) were utilized, the silica catalysts exhibit high space time yields (at low conversions) for methane partial oxidation to formaldehyde, and the C2 hydrocarbons were found to be parallel products with formaldehyde. In general, the selectivities toward CO were high while those toward CO2 were low. Based on the present results obtained by a double catalyst bed experiment, the observations of product composition dependence on the variation of GHSV (i.e. gas residence time), and differences in apparent activation energies of formation of C2H6, and CH2O, a reaction mechanism is proposed for the activation of methane over the silica surface. This mechanism can explain the observed product distribution patterns (specifically the parallel formation of formaldehyde and C2 hydrocarbons). DOE

N93-27000*# SRI International Corp., Menlo Park, CA.
CHEMICAL ANALYSES OF PROVIDED SAMPLES Final Report
Christopher H. Becker Apr. 1993 19 p Sponsored by NASA. Marshall Space Flight Center
(SRI Proj. 3557)
(NASA-CR-193207; NAS 1.26:193207; MP-93-084) Avail: CASI HC A03/MF A01

A batch of four samples were received and chemical analysis was performed of the surface and near surface regions of the samples by the surface analysis by laser ionization (SALI) method. The samples included four one-inch diameter optics labeled windows no. PR14 and PR17 and MgF2 mirrors 9-93 PPPC exp. and control DMES 26-92. The analyses emphasized surface contamination or modification. In these studies, pulsed desorption by 355 nm laser light and single-photon ionization (SPI) above the sample by coherent 118 nm radiation (at approximately 5 x 10(exp 5) W/cm(sup 2)) were used, emphasizing organic analysis. For the two windows with an apparent yellowish contaminant film, higher desorption laser power was needed to provide substantial signals, indicating a less volatile contamination than for the two mirrors. Window PR14 and the 9-93 mirror showed more hydrocarbon components than the other two samples. The mass spectra, which show considerable complexity, are discussed in terms of various potential chemical assignments. Author (revised)

N93-27077*# SRI International Corp., Menlo Park, CA.
CHEMICAL ANALYSES OF PROVIDED SAMPLES Final Report
Christopher H. Becker 1 Mar. 1993 40 p Sponsored by NASA. Marshall Space Flight Center
(SRI Proj. 3557)
(NASA-CR-193211; NAS 1.26:193211; MP-93-044) Avail: CASI HC A03/MF A01

Two batches of samples were received and chemical analysis was performed of the surface and near surface regions of the samples by the surface analysis by laser ionization (SALI) method. The samples included four one-inch optics and several paint samples. The analyses emphasized surface contamination or modification. In these studies, pulsed sputtering

by 7 keV Ar+ and primarily single-photon ionization (SPI) by coherent 118 nm radiation (at approximately 5 x 10(exp 5) W/cm(sup 2) were used. For two of the samples, also multiphoton ionization (MPI) at 266 nm (approximately 5 x 10(exp 11) W/cm(sup 2) was used. Most notable among the results was the silicone contamination on Mg2 mirror 28-92, and that the Long Duration Exposure Facility (LDEF) paint sample had been enriched in K and Na and depleted in Zn, Si, B, and organic compounds relative to the control paint. Author (revised)

N93-27105# Pacific Northwest Lab., Richland, WA.
STATUS AND INTEGRATION OF THE GAS GENERATION STUDIES PERFORMED FOR THE HYDROGEN SAFETY PROGRAM
L. R. Pederson and D. M. Strachan Feb. 1993 38 p
(Contract DE-AC06-76RL-01830)
(DE93-008518; PNL-8523) Avail: CASI HC A03/MF A01

Waste in Tank 241-SY-101 on the Hanford Site generates and periodically releases hydrogen, nitrous oxide, and nitrogen gases. Studies have been conducted at several laboratories to determine the chemical mechanisms for the gas generation and release. Results from these studies are presented and integrated in an attempt to describe current understanding of the physical properties of the waste and the mechanisms of gas generation and retention. Existing tank data are consistent with the interpretation that gases are uniformly generated in the tank, released continuously from the convecting layer, and stored in the nonconvecting layer. Tank temperature measurements suggest that the waste consists of 'gobs' of material that reach neutral buoyancy at different times. The activation energy of the rate limiting step of the gas generating process was calculated to be about 7 kJ/mol but measured in the laboratory at 80 to 100 kJ/mol. Based on observed temperature changes in the tank the activation energy is probably not higher than about 20 kJ/mol. Several simulated waste compositions have been devised for use in laboratory studies in the place of actual waste from Tank 241-SY-101. Data from these studies can be used to predict how the actual waste might behave when heated or diluted. Density evaluations do not confirm that heating waste at the bottom of the tank would induce circulation within the waste; however, heating may release gas bubbles by dissolving the solids to which the bubbles adhere. Gas generation studies on simulated wastes indicated that nitrous oxide and hydrogen yields are not particularly coupled. Solubility studies of nitrous oxide, the most soluble of the principal gaseous products, indicate it is unlikely that dissolved gases contribute substantially to the quantity of gas released during periodic events. DOE

N93-27223*# Scientific Research Associates, Inc., Glastonbury, CT.
SIMULATION OF PREBURNER SPRAYS, VOLUMES 1 AND 2 Final Report, 3 Apr. 1991 - 3 Apr. 1993
Y. Hardalupas and J. H. Whitelaw May 1993 206 p Prepared in cooperation with Imperial Coll. of Science and Technology, London, England
(Contract NAS8-38872)
(NASA-CR-193031; NAS 1.26:193031; SRA-R93-9083-F-Vol-1-2) Avail: CASI HC A10/MF A03

The present study considered characteristics of sprays under a variety of conditions. Control of these sprays is important as the spray details can control both rocket combustion stability and efficiency. Under the present study Imperial College considered the following: (1) Measurement of the size and rate of spread of the sprays produced by single coaxial airblast nozzles with axial gaseous stream. The local size, velocity, and flux characteristics for a wide range of gas and liquid flowrates were measured, and the results were correlated with the conditions of the spray at the nozzle exit. (2) Examination of the effect of the geometry of single coaxial airblast atomizers on spray characteristics. The gas and liquid tube diameters were varied over a range of values, the liquid tube recess was varied, and the shape of the exit of the gaseous jet was varied from straight to converging. (3) Quantification of the effect of swirl in the gaseous stream on the spray characteristics produced by single coaxial airblast nozzles. (4) Quantification of the effect of reatomization by impingement of the spray on a flat disc positioned around 200 mm from the nozzle exit. This models spray impingement on the turbopump dome during the startup process of the preburner of the SSME. (5) Study of the interaction between multiple sprays without and with swirl in their gaseous stream. The spray characteristics of single nozzles were compared with that of three identical nozzles with their axis at a small distance from each other. This study simulates the sprays in the preburner of the SSME, where there are around 260 elements on the faceplate of the combustion chamber. (6) Design an experimental facility to study the characteristics of sprays at high pressure conditions and at supercritical pressure and temperature for the gas but supercritical pressure and subcritical temperature for the liquid. Author (revised)

N93-27485# Department of Energy, Morgantown, WV. Technology Center.
PARTIAL OXIDATION OF ETHANE AND ETHYLENE IN THE PRESENCE AND ABSENCE OF C-13 LABELED METHANE ON REDUCIBLE AND NON-REDUCIBLE OXIDE CATALYSTS
A. Shamsi 1993 12 p Presented at the 205th American Chemical Society National Meeting, Denver, CO, 28 Mar. - 2 Apr. 1993
(DE93-008252; DOE/METC-C/93/7052; CONF-930304-5) Avail: CASI HC A03/MF A01

The most widely acceptable mechanism for activation of methane appears to be the reaction of methane from the gas phase with surface oxygen, which abstracts hydrogen from methane to form methyl radicals. The methyl radicals are released into the gas phase and form ethane. However, the reaction pathways for activation of ethane and ethylene are not well established. The relative H-abstraction rates for hydroxyl radicals in the gas phase for C2H6/CH4 and C2H4/PH4 are reported. From these data and a suggestion that the C-H bond strength in ethylene is greater than methane, the relative gas-phase reactivity can be estimated to be in the order of C2H6 is greater than CH4 is greater than C2H4. However, this order was not observed in this study, and it has been reported only for the LiCl/MnO(x) catalyst, indicating that the H-abstraction is not the only pathway for ethane and ethylene activation. Likewise, depending on the catalyst and the experimental conditions, C-C and C=C bonds are also attacked by the active centers on the catalyst and by the active species in the gas phase. Therefore, the relative reactivity of ethane and ethylene compared to methane appears to strongly depend on the partial pressures of reactants and the type of catalysts used. The relative reactivities are in the order of ethylene is greater than ethane is much greater than methane for reactions in the gas phase and on the catalysts containing reducible oxides of transition metals such as Ca/Ni/K. However, this order changed to ethane is greater than ethylene is much greater than methane for a non-reducible catalyst such as sodium promoted Sm2O3. Oxidation of ethane and ethylene in the presence of methane and catalyst show that methane and ethylene, depending on their partial pressures, compete for active centers, and neither formaldehyde nor ethylene oxide were detected in the presence of methane and the catalyst. DOE

N93-27487# Grambling State Univ., LA. Dept. of Physics.
NQR-NMR STUDIES OF HIGHER ALCOHOL SYNTHESIS Cu-Co CATALYSTS
A. N. Murty 1992 9 p
(Contract DE-FG22-89PC-89762)
(DE93-009698; DOE/PC-89762/T17) Avail: CASI HC A02/MF A01

We have investigated a series of Cu/Co catalysts supported on titanium dioxide. This study has sought to examine and compare the nature and effect of the supports chromia and titania (Cr2O3, and TiO2) on the magnetic character of the Cu-Co-Cr and Cu-Co-TiO2 catalysts. The magnetization results for Cu/Co, Cu/Co/Cr, and Cu/Co/TiO2 systems are presented along with the magnetization data for the unsupported Cu/Co catalysts and data for supported catalysts. Pure cobalt metal has a magnetic moment of 161 emu/g. The measured emu values and the corresponding reduction percentages are given for the various catalysts investigated. The vibration sample magnetometer determines S(sub s), the saturation magnetization, emu per gram of the composite sample. The magnetization values reported are emu per gram of cobalt in the composite. As such the data normally reflects the proportion of cobalt metal that is reduced to metallic form. However, if electronic exchanges occur between cobalt and other elements in the system, the magnetic moment itself differs from the assumed value of 161 emu/g Co then the emu value observed will be the resultant due to the electronic charge density modifications in Co as well as reduction to metallic state. Our earlier NMR studies reveal such electronic structural modifications occur for cobalt in Cu-Co and Co-TiO2 systems. The magnetization data in column 3 for Cu-Co-TiO2 systems unambiguously shows such electron exchanges do occur between cobalt and titania.

DOE

N93-27602# Aerospace Corp., El Segundo, CA. Mechanics and Materials Technology Center.

INVESTIGATION OF MULTIPLY ALKYLATED CYCLOPENTANE SYNTHETIC OIL AND LEAD NAPHTHENATE ADDITIVE UNDER BOUNDARY CONTACT INTERACTIONS

Michael R. Hilton, Chris G. Kalogeras, and Stephen V. Didziulis 15 Apr. 1993 72 p

(ATR-93(8361)-1) Avail: CASI HC A04/MF A01

A reciprocating-ball wear tester was used to study the behavior of multiply alkylated cyclopentane (MAC) synthetic hydrocarbon oil (Pennzane SHF-2000) in boundary contact conditions. The tester simulates conditions found in the wave-generator bearings of a harmonic drive mechanism. This report documents the performance of SHF-2000 formulated with and without lead naphthenate (Pbnp) boundary additive. Tests of NPT-4 ester oil (without additive) were conducted to provide a baseline. During tests, displacement data were obtained in order to monitor component wear (or additive film buildup). Posttest analyses included profilometry, scanning electron microscopy, x-ray photoelectron spectroscopy, and Auger electron spectroscopy. The presence of Pbnp provides the best protection against wear, although pure SHF-2000 alone provided better protection against wear than pure NPT-4. The combined data provide a consistent understanding of how Pbnp reacts and deforms in boundary contact. This knowledge is useful for the prediction of performance under conditions not yet tested and for the selection of lubricants to be used in future spacecraft mechanisms. Author

N93-27938# Technische Univ., Delft (Netherlands). Dept. of Chemical Process Technology.

DEVELOPMENT OF A HIGH TEMPERATURE STEAM REGENERATIVE H2S REMOVAL PROCESS BASED ON ALUMINA SUPPORTED MnO AND FeO Ph.D. Thesis

Johan Peter Wakker 1992 203 p

(ETN-93-93617) Avail: CASI HC A10/MF A03

A study to develop a process that removes H2S and CoS at high temperatures (675 to 1075K) from fuel gases produced by a coal gasifier is presented. These fuel gases can be used for the production of electricity in a combined cycle power plant, or as a synthesis gas for the production of substitute natural gas or chemicals. An overview of H2S removal is given and the preparation of manganese and iron containing acceptors is described. Different preparation techniques are used to obtain the most active acceptor material. Impregnation results in the most active and stable acceptors. The characterization of alumina supported manganese oxide acceptors prepared by pore volume impregnation by means of Temperature Programmed Reduction (TPR) and Solidification (TPS), High Resolution Electron Microscopy (HREM) and X-ray Photoelectron Spectroscopy (XPS), is described. The influence of process conditions such as temperature, pressure and gas composition is given. The results of regeneration experiments and the optimization of the regeneration conditions, and the testing of the acceptor materials under realistic conditions in a bench scale unit with a gas produced by a coal gasifier, are discussed. The quantitative modeling of sulfidation and regeneration curves and an evaluation concerning reactor design and economics of the process are given. ESA

N93-28159# Sandia National Labs., Livermore, CA.

RESONANT MODE INTERACTIONS AND THE BIFURCATION OF COMBUSTION-DRIVEN ACOUSTIC OSCILLATIONS IN RESONANCE TUBES

S. B. Margolis Jan. 1993 47 p

(Contract DE-AC04-76DR-00789)

(DE93-009448; SAND-93-8487) Avail: CASI HC A03/MF A01

Acoustic oscillations in practical combustion devices such as pulse combustors and rocket motors, whether desirable or not, are properly interpreted as combustion instabilities. A nonlinear stability analysis of the corresponding fluid motions then shows that the nonsteady behavior is governed by infinitely coupled systems of nonlinear evolution equations for the amplitudes of the classical acoustic modes. However, under certain conditions, it has been conjectured that relatively low-order truncations can give qualitatively correct physical results. In the present work we consider one particular model of a pulse combustor, and focus on a parameter regime in the neighborhood of a primary acoustic bifurcation where either one or a pair of purely longitudinal acoustic modes achieves a positive linear growth rate. In the first case, it is formally shown that a decoupling occurs such that a two-mode approximation consisting of the linearly unstable mode and its first resonant harmonic completely determines the dynamics of the oscillation. In the latter case, it is again demonstrated that a decoupling occurs, and although mode interactions require the retention of additional modes besides the two linearly unstable modes and their first resonant harmonics, a relatively low-order dynamical system still governs the bifurcation behavior. The presence of two linearly unstable modes is then shown to lead to more complicated dynamics, including the stable secondary bifurcation of a multi-periodic acoustic oscillation from one of the single-period primary branches. DOE

N93-28186# George Washington Univ., Washington, DC. Dept. of Chemistry.

NON-ADIABATIC CURVE CROSSINGS IN DISSOCIATIVE ELECTRON ATTACHMENT OF CONDENSED O2

Hideo Sambe and David E. Ramaker Dec. 1992 40 p

(Contract N00014-91-J-1896)

(AD-A262129; TR-62) Avail: CASI HC A03/MF A01

Previously published data on electron stimulated desorption (ESD) from condensed O2 or O2(+) in matrices have been analyzed. Dissociative electron attachment (DEA) via the 2 Sigma sub g(+) resonant state can result in two different dissociation products (i.e. by proceeding to the dissociation limits O(3p) + O(-)(2-P) and O*(1D) + O(-)2(P)). The O*(1D) product requires dissociation via a non-adiabatic curve crossing. O*(1D) is the dominant DEA product in gaseous O2. Upon condensation, O(3P) becomes the dominant product; however, the branching ratio depends strongly on the kinetic energy of the dissociating atoms. DTIC

N93-28187# Illinois Univ., Urbana. Dept. of Electrical and Computer Engineering.

CRYOGENIC ULTRAHIGH VACUUM SCANNING TUNNELING MICROSCOPY Semiannual Report, 1 Aug. 1992 - 31 Jan. 1993

Joseph W. Lyding 11 Mar. 1993 6 p

(Contract N00014-91-J-1675)

(AD-A262264; UILU-ENG-90-2538) Avail: CASI HC A02/MF A01

This report describes recent progress towards the development of a variable temperature cryogenic UHV-STM. The transition from STM-based nanolithography and the loss of a good graduate student (to Stanford) has slowed this project. However, a part-time postdoc has been hired and a new student is being recruited. The apparatus is now essentially complete as a stand alone system, and the testing sequence has begun. DTIC

N93-28226# Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Aerospace and Ocean Engineering.

DIRECT MEASUREMENTS OF SKIN FRICTION IN SUPERSONIC COMBUSTION FLOW FIELDS

K. M. Chadwick, D. J. DeTurris, J. A. Schetz, and R. F. Hellbaum Mar. 1993 17 p

(Contract MIPR-FY1455-90-N0658)

(AD-A262878; WL-TR-93-2051) Avail: CASI HC A03/MF A01

The final report consists of an AIAA and an ASME paper. An experimental investigation was conducted to measure skin friction along the chamber walls of supersonic combustors. A direct force measurement device was used to simultaneously measure an axial and transverse component of the small tangential shear force passing over a non-intrusive floating element. Skin friction coefficients between 0.001-0.005 were measured dependent on the facility and measurement location. Analysis of the measurement uncertainties indicate an accuracy to within + or - 10-15% of the streamwise component. DTIC

N93-28229# Pacific Northwest Lab., Richland, WA.

SOFC CHROMITE SINTERING AND ELECTROLYTE/AIR-ELECTRODE INTERFACE REACTIONS

J. L. Bates, L. A. Chick, and G. E. Youngblood Apr. 1992 5 p Presented at the Workshop of Fuel Cell Technology Research and Development, San Francisco, CA, 29-30 Apr. 1992

(Contract DE-AC06-76RL-01830)

(DE93-008260; PNL-SA-20784; CONF-9204231-1) Avail: CASI HC A01/MF A01

Air sintering of chromites was investigated in LaSrCrO3, LaCaCrO3, and YCaCrO3. Effects of alkaline earth dopant level and chromium

enrichment/depletion on chromite sintered densities and microstructures are discussed. Impedance spectroscopy (ac) and dc polarization coupled with an unbonded interface cell were used to examine SOFC (solid oxide fuel cells) electrochemical reactions at solid-solid-gas interfaces, particularly for La(1-x)Sr(x)MnO3. DOE

N93-28245# Minnesota Univ., Minneapolis. Dept. of Chemical Engineering and Materials Science.
MONTE CARLO SIMULATIONS OF SOLVENT EFFECTS ON CONFINED ELECTROLYTES
Lianrui R. Zhang, Henry S. White, and H. T. Davis 20 Mar. 1993 11 p Presented at the Symposium on Microscopic Models of Electrode Electrolyte Interfaces, Toronto, Ontario, 11-16 Oct. 1992 Submitted for publication
(Contract N00014-91-J-1927)
(AD-A262292; TR-23) Avail: CASI HC A03/MF A01

Monte Carlo simulations are reported for 1:1 electrolytes confined between electrically charged and neutral surfaces. Both solvent and ions are modeled as hard spheres with hard sphere and Coulomb interactions. Density profiles of solvent and ions and electrostatic potential profiles are presented for electrolyte concentrations of 1 and 2 M and for different cation sizes at 300 K. Comparison of results at charged and neutral walls indicates that the density distribution of the solvent near a wall induces significant layering of ions and a decrease in the potential in the double layer. This layering effect cannot be captured in simulations of the conventional primitive model (PM) of the double layer. DTIC

N93-28294# Brookhaven National Lab., Upton, NY.
HIGH RESOLUTION NEAR EDGE X RAY SPECTROSCOPY
K. Haemaelaeinen, D. P. Siddons, L. E. Berman, C. C. Kao, and J. B. Hastings 1992 9 p Presented at the International Conference on Anomalous Scattering (ICAS) Conference, Hamburg, Germany, 17-21 Aug. 1992
(Contract DE-AC02-76CH-00016)
(DE93-003471; BNL-48042; CONF-9208186-1) Avail: CASI HC A02/MF A01

A technique to suppress the core-hole lifetime broadening in near-edge x-ray spectroscopy is presented. A simple theoretical explanation based on total energy conservation in the fluorescence process is given to explain the improved resolution. The experimental arrangement is shown together with an application to the L(sub 3) edge of dysprosium. Furthermore, the application of high-resolution fluorescence spectroscopy in the study of magnetism is presented. The spin-resolved absorption spectra from MnF(sub 2) are shown as an example. DOE

N93-28309# Brookhaven National Lab., Upton, NY.
PHOTOCONDUCTIVITY MEASUREMENTS OF X RAY ABSORPTION FINE STRUCTURES IN LIQUIDS IN THE SOFT X RAY REGION: Si AND Cl K-EDGE
T. K. Sham (University of Western Ontario, London.), J. Z. Xiong (University of Western Ontario, London.), X. H. Feng (University of Western Ontario, London.), R. A. Holroyd, and B. X. Yang (Chicago Univ., IL.) 1992 5 p Presented at the 7th International Conference on XRay Absorption Fine Structure, Kobe, Japan, 23-29 Aug. 1992
(Contract DE-AC02-76CH-00016)
(DE93-006670; BNL-48487; CONF-9208160-6) Avail: CASI HC A01/MF A01

Photoconductivity measurements of x-ray absorption fine structures (XAFS) at the Si and Cl K-edge have been carried out in a liquid cell for (CH3)4.Si((CH3)3)Si)4Si and either as a pure liquid or 2,2,4-trimethylpentane solution. It is found that for the pure liquids and their concentrated hydrocarbon solutions, all K-edge XAFS spectra, are inverted as expected under the condition of total absorption. A sharp conductivity dip is also observed in CCl4 at the Cl K-edge. The concentration dependence of the XAFS spectrum of CCl4 is reported. These results are discussed in terms of soft x-ray induced ion yields of the solute and solvent molecules in liquids. DOE

N93-28352# Colorado School of Mines, Golden. Dept. of Chemical Engineering and Petroleum Refining.
COMPOSITION DEPENDENCE OF FLUID THERMOPHYSICAL PROPERTIES: THEORY AND MODELING Report, 1 Aug. 1992 - 31 Jul. 1993
James F. Ely 29 Mar. 1993 13 p
(Contract DE-FG02-92ER-14294)
(DE93-011119; DOE/ER-14294/1) Avail: CASI HC A03/MF A01

The objective is the study of the equilibrium/nonequilibrium properties of asymmetric fluid mixtures through computer simulation (CS), development of predictive theories of mixture equilibrium properties, development and application of selection algorithm methodology for mixture equations of state, and use of theory to develop new engineering design models for fluid mixtures. A Kirkwood charging method CS of Lennard-Jones mixtures with large size ratios verified the Kirkwood-Buff/Baxter method of calculating chemical potentials. A CS of n-butane showed that the rheology is not a function of system size. A modified stepwise regression algorithm was developed and applied to HFC R134a. An analytical expression was developed for conformal solution size correction for mixtures. The extended corresponding states theory (ECST) can be applied to systems having large polarity differences; an accurate representation was developed of bulk phase properties of water-hydrocarbon systems. It was found how to force ECST to reach the correct virial limit. DOE

N93-28360# Washington Univ., Seattle. Dept. of Physics.
X RAY AND GAMMA RAY SPECTROSCOPY OF SOLIDS UNDER PRESSURE
R. L. Ingalls 30 Apr. 1992 6 p
(Contract DE-FG06-84ER-45163)
(DE93-010966; DOE/ER-45163/30) Avail: CASI HC A02/MF A01

The effort is divided into the following sections: high pressure transitions (Fe, RbCl), XAFS studies of perovskites under pressure (ReO3), high-(Tc) superconductors, studies of XANES of alkali halides, and Moessbauer studies (iron silicate spinel). DOE

N93-28374# AMAX Research and Development Center, Golden, CO.
DEVELOPMENT OF VANADIUM-PHOSPHATE CATALYSTS FOR METHANOL PRODUCTION BY SELECTIVE OXIDATION OF METHANE
R. L. McCormick and M. C. Jha Mar. 1993 23 p
(Contract DE-AC22-92PC-92110)
(DE93-012568; DOE/PC-92110/T1) Avail: CASI HC A03/MF A01

Amax R&D will perform laboratory scale development of a promising, practical catalyst for the selective oxidation of methane to methanol. The primary component of this catalyst is vanadium-phosphate (VPO) which has shown good activity and selectivity in the partial oxidation of n-butane and propane but has not been studied in detail for methane oxidation. The goal of the project is to develop a catalyst which allows methane oxidation to methanol to be conducted at high conversion and selectivity. A low CH4/O2 ratio will be employed with air as the source of oxygen. Temperatures below 600 C and pressures up to 20 atm are investigated. The use of steam in the feed gas is also investigated. The catalyst development strategy will be to utilize promoters and supports to improve the activity and selectivity of the unmodified VPO catalyst. The catalyst testing reactor system was used to perform blank (empty) reactor runs over a wide range of temperatures, pressure, and flow rates. No methane conversion was observed at temperatures of 500 C or lower in any of the tests. At higher temperatures, significant methane conversion to carbon dioxide was observed. At 550 C, 300 psig, and the highest flow rate studied, reactor ignition was observed. Based on the results of these blank runs, it is concluded that catalyst testing should be performed at temperatures not to exceed 500 C. DOE

N93-28407*# Alabama Univ., Huntsville. Materials Processing Lab.
COMBINED SPACE ENVIRONMENT ON SPACECRAFT ENGINEERING MATERIALS Final Report
Gary L. Workman, Guy A. Smith, and Susan Kosten 30 Apr. 1993 25 p
(Contract NAS8-38609)
(NASA-CR-192536; NAS 1.26:192536) Avail: CASI HC A03/MF A01

Spacecraft structures and surface materials exposed to the space environment for extended periods, up to thirty years, have increased potential for damage from long term exposure to the combined space environment including solar ultraviolet radiation, electrons, and protons and orbiting space debris. The space environment in which the Space Station Freedom and other space platforms will orbit is truly a hostile environment. For example, the currently estimated integral fluence for electrons above 1 Mev at 2000 nautical miles is above 2 x 10(exp 10) electrons/cm(sup 2)/day and the

proton integral fluence is above 1 x 10(exp 9) protons/cm(sup 2)/day. At the 200 - 400 nautical miles, which is more representative of the altitude which will provide the environment for the Space Station, each of these fluences will be proportionately less; however, the data indicates that the radiation environment will obviously have an effect on structural materials exposed to the environment for long durations. The effects of ultraviolet radiation, particularly in the vacuum ultraviolet (less than 200 nm wavelength) is more difficult to characterize at this time. Very little data is available in the literature which can be used for determining the life cycle of a material placed in space for extended durations of time. In order to obtain critical data for planning and designing of spacecraft systems, use of a small vacuum system at the Environmental Effects Facility at MSFC, which can be used for these purposes was used. A special effort was made to build up this capability during the course of this research effort and perform a variety of experiments on materials proposed for the Space Station. A description of the apparatus and the procedure devised to process potential spacecraft materials is included. Author (revised)

N93-28452# Sandia National Labs., Livermore, CA.
PROGRESS IN OPTICAL DIAGNOSTIC DEVELOPMENT FOR THE ELECTRO-THERMAL CHEMICAL PROGRAM
S. R. Vosen and R. C. Armstrong Feb. 1993 22 p
(Contract DE-AC04-76DR-00789)
(DE93-009452; SAND-93-8209) Avail: CASI HC A03/MF A01

Progress is reported on a development program whose goals are techniques suitable for the study of mixing and combustion during the electro-thermal chemical propulsion process. Specifically, it was desired to develop an optical technique capable of determining the location, extent, and structure of a plasma-liquid interface at gun-like conditions and to determine the location and intensity of combustion at that interface. Details of the adaptation of techniques developed for the study of liquid propellant combustion to ETC-like phenomena are described in this report. This includes how to obtain photographs capable of being analyzed to determine both the location and structure of the plasma-liquid interface and locations of regions undergoing chemical reactions and details of digital image processing techniques useful in obtaining this information. DOE

N93-26676*# Arizona Univ., Tucson. Dept. of Chemical Engineering.
REDUCTION OF IRON-BEARING LUNAR MINERALS FOR THE PRODUCTION OF OXYGEN
Charles Massieon, Andrew Cutler, and Farhang Shadman *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 43 p (For primary document see N93-26674 10-91)
Avail: CASI HC A03/MF A03; 1 functional color page

N93-26677*# Arizona Univ., Tucson. Dept. of Materials Science and Engineering.
INNOVATIVE TECHNIQUES FOR THE PRODUCTION OF ENERGETIC RADICALS FOR LUNAR PROCESSING INCLUDING COLD PLASMA PROCESSING OF LOCAL PLANETARY ORES
D. Bullard and D. C. Lynch *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 8 p (For primary document see N93-26674 10-91)
Avail: CASI HC A02/MF A03; 1 functional color page

N93-26678*# Washington Univ., Saint Louis, MO. Dept. of Earth and Planetary Science.
OXYGEN AND IRON PRODUCTION BY ELECTROLYTIC SMELTING OF LUNAR SOIL
R. O. Colson and L. A. Haskin *In* Arizona Univ., NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 22 p (For primary document see N93-26674 10-91)
Avail: CASI HC A03/MF A03; 1 functional color page

N93-26679*# EMEC Consultants, Export, PA.
EXPERIMENTAL STUDY OF THE ELECTROLYSIS OF SILICATE MELTS
Rudolf Keller *In* Arizona Univ., NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 10 p (For primary document see N93-26674 10-91)
Avail: CASI HC A02/MF A03; 1 functional color page

N93-26680*# Arizona State Univ., Tempe. Dept. of Geology.
LUNAR MINING OF OXYGEN USING FLUORINE
Donald M. Burt, James A. Tyburczy, Jeffery J. Roberts, and Rajan Balasubramanian *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 9 p (For primary document see N93-26674 10-91)
Avail: CASI HC A02/MF A03; 1 functional color page

N93-26681*# Arizona Univ., Tucson. Dept. of Mining and Geological Engineering.
BENEFICIATION OF ILMENITE FROM LUMAR ANALOG
G. Ramadorai and R. Dean *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 10 p (For primary document see N93-26674 10-91)
Avail: CASI HC A02/MF A03; 1 functional color page

N93-26682*# Arizona Univ., Tucson. Lunar and Planetary Lab.
EXTRACTION OF VOLATILES AND METALS FROM EXTRATERRESTRIAL MATERIALS
J. S. Lewis *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 9 p (For primary document see N93-26674 10-91)
Avail: CASI HC A02/MF A03; 1 functional color page

N93-26684*# Arizona Univ., Tucson. Dept. of Geosciences.
DEHYDRATION KINETICS AND THERMOCHEMISTRY OF SELECTED HYDROUS PHASES, AND SIMULATED GAS RELEASE PATTERN IN CARBONACEOUS CHONDRITES
Kunal Bose and J. Ganguly *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 14 p (For primary document see N93-26674 10-91)
Avail: CASI HC A03/MF A03; 1 functional color page

N93-27175 Princeton Univ., NJ. Dept. of Mechanical and Aerospace Engineering.
AEROSPACE APPLICATIONS OF METAL COMBUSTION
Irvin Glassman *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 57-64 (For primary document see N93-27166 10-01)
Copyright Avail: Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel

N93-28255*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
LDEF MATERIALS OVERVIEW
Bland A. Stein *In its* LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 741-789 (For primary document see N93-28254 10-99)
Avail: CASI HC A03/MF A04; 2 functional color pages

N93-28256*# Manchester Univ. (England). Dept. of Geology.
OXYGEN ISOTOPES IMPLANTED IN THE LDEF SPACECRAFT
J. M. Saxton, I. C. Lyon, E. Chatzitheodoridis, P. VanLierde (VG Isotech, Middlewich, England.), J. D. Gilmour, and G. Turner *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 791-796 (For primary document see N93-28254 10-99)
Avail: CASI HC A02/MF A04; 2 functional color pages

N93-28257*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
SILAZINE TO SILICA
Gale A. Harvey *In its* LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 797-810 (For primary document see N93-28254 10-99)
Avail: CASI HC A03/MF A04; 2 functional color pages

N93-28258*# LeTourneau Coll., Longview, TX.
STABILITY AND REACTIVITY OF DIMETHYLETHOXYSILANE
Richard E. Johnson and Douglas I. Ford *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval

Symposium Apr. 1993 p 811-825 Sponsored by NASA. Johnson Space Center (For primary document see N93-28254 10-99)
Avail: CASI HC A03/MF A04; 2 functional color pages

N93-28272*# Boeing Defense and Space Group, Seattle, WA.
CONTAMINATION ON LDEF: SOURCES, DISTRIBUTION, AND HISTORY
Gary Pippin and Russ Crutcher *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 1023-1031 (For primary document see N93-28254 10-99)
(Contract NAS1-19247)
Avail: CASI HC A02/MF A04; 2 functional color pages

N93-28273*# Aerospace Corp., El Segundo, CA.
CONTAMINATION MEASUREMENTS ON EXPERIMENT M0003 Abstract Only
Eugene N. Borson and F. Barry Sinsheimer *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 1033 (For primary document see N93-28254 10-99)
(Contract F04701-88-C-0089)
Avail: CASI HC A01/MF A04; 2 functional color pages

N93-28285*# Boeing Defense and Space Group, Seattle, WA.
LDEF MATERIALS DATA ANALYSIS: REPRESENTATIVE EXAMPLES
Gary Pippin and Russ Crutcher *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 1187-1199 (For primary document see N93-28254 10-99)
(Contract NAS1-19247)
Avail: CASI HC A03/MF A04; 2 functional color pages

26 METALLIC MATERIALS

Includes physical, chemical, and mechanical properties of metals, e.g., corrosion; and metallurgy.

N93-26898*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
LOW CYCLE FATIGUE BEHAVIOR OF POLYCRYSTALLINE NiAl AT 300 AND 1000 K
Bradley A. Lerch and Ronald D. Noebe Apr. 1993 48 p
(RTOP 510-01-50)
(NASA-TM-105987; E-7566; NAS 1.15:105987) Avail: CASI HC A03/MF A01

The low cycle fatigue behavior of polycrystalline NiAl was determined at 300 and 1000 K - temperatures below and above the brittle- to-ductile transition temperature (BDTT). Fully reversed, plastic strain-controlled fatigue tests were conducted on two differently fabricated alloy samples: hot isostatically pressed (HIP'ed) prealloyed powder and hot extruded castings. HIP'ed powder (HP) samples were tested only at 1000 K, whereas the more ductile cast-and-extruded (C+E) NiAl samples were tested at both 1000 and 300 K. Plastic strain ranges of 0.06 to 0.2 percent were used. The C+E NiAl cyclically hardened until fracture, reaching stress levels approximately 60 percent greater than the ultimate tensile strength of the alloy. Compared on a strain basis, NiAl had a much longer fatigue life than other B2 ordered compounds in which fracture initiated at processing-related defects. These defects controlled fatigue life at 300 K, with fracture occurring rapidly once a critical stress level was reached. At 1000 K, above the BDTT, both the C+E and HP samples cyclically softened during most of the fatigue tests in air and were insensitive to processing defects. The processing method did not have a major effect on fatigue life; the lives of the HP samples were about a factor of three shorter than the C+E NiAl, but this was attributed to the lower stress response of the C+E material. The C+E NiAl underwent dynamic grain growth, whereas the HP material maintained a constant grain size during testing. In both materials, fatigue life was controlled by intergranular cavitation and creep processes, which led to fatigue crack growth that was primarily intergranular in nature. Final fracture by overload was transgranular in nature. Also, HP samples tested in vacuum had a life three times longer than their counterparts tested in air and, in contrast to those tested in air, hardened continuously over half of the sample life, thereby indicating an environmentally assisted fatigue damage mechanism. The C+E samples were tested only in air. At 1000 K, NiAl exhibited a superior fatigue life when compared to most superalloys on a plastic strain basis, but was inferior to most superalloys on a stress basis. Author

N93-26940# Westinghouse Savannah River Co., Aiken, SC.
ORIENTATION DEPENDENCY OF MECHANICAL PROPERTIES OF 1950'S VINTAGE TYPE 304 STAINLESS STEEL WELDMENT COMPONENTS BEFORE AND AFTER LOW TEMPERATURE NEUTRON IRRADIATION
R. L. Sindelar and G. R. Caskey, Jr. 1992 11 p Presented at the Minerals, Metals, and Materials Society/American Society for Metals (TMS/ASM) Materials Week 1992, Chicago, IL, 2-5 Nov. 1992
(Contract DE-AC09-89SR-18035)
(DE93-005168; WSRC-MS-92-138; CONF-9211117-5) Avail: CASI HC A03/MF A01

Databases of mechanical properties for both the piping and reactor vessels at the Savannah River Site (SRS) were developed from weldment components (base, weld, and weld heat-affected-zone (HAZ)) of archival piping specimens in the unirradiated and irradiated conditions. Tensile, Charpy V-notch (CVN), and Compact Tension C(T) specimens were tested at 25 and 125 C before and after irradiation at low temperatures (90 to 150 C) to levels of 0.065 to 2.1 dpa. Irradiation hardened the weldment components and reduced the absorbed energy and toughness properties from the unirradiated values. A marked difference in the Charpy V-notch absorbed energy and the elastic-plastic fracture toughness (J(sub IC)) was observed for both the base and HAZ components with the C-L orientation being lower in toughness than the L-C orientation in both the unirradiated and irradiated conditions. Fracture surface examination of the base and HAZ components of unirradiated C(T) specimens showed a 'channel' morphology in the fracture surfaces of the C-L specimens, whereas equiaxed ductile rupture occurred in the L-C specimens. Chromium carbide precipitation in the HAZ component reduced the fracture toughness of the C-L and L-C specimens compared to the respective base component C-L and L-C specimens. Optical metallography of the piping materials showed stringers of second phase particles parallel to the rolling direction along with a banding or modulation in the microchemistry perpendicular to the pipe axis or rolling direction of the plate material. DOE

N93-27374# Technische Univ., Eindhoven (Netherlands).
BACKWARD CAN EXTRUSION AND MATERIALS BEHAVIOUR Ph.D. Thesis
Wilhelmus Hubertina Sillekens 1992 140 p
(ISBN-9-03-860032-1; ETN-93-93153) Avail: CASI HC A07/MF A02

The bulk forming process of backward can extrusion, a metal forming process for the production of can shaped parts, in relation to the plastic behavior of the worked material is studied. Methods of modeling for the backward can extrusion process are reviewed, classified by the adopted approach in experimental, analytical, and numerical treatment. Four upperbound models, obtained from various sources in literature, are introduced and evaluated vis a vis with respect to their individual validity. These models apply to the important category of cylindrical products. Plastic behavior of materials is discussed. Characteristics quantities are discussed, representing distinct features of the material's formability. These characteristic quantities can be used to assess the suitability of new materials for forming applications. This is demonstrated for a rather uncommon material: recycled aluminum, reclaimed via rapid solidification processing. Flow behavior, one of the relevant features of formability, is explored. The anomalies on flow behavior, arising from more or less abrupt changes in the strain path are considered; many actual forming processes, including backward can extrusion, involve such changes. Modeling of the extrusion process is considered. An application which deals with the ductility of the workpiece material is reported. This implementation combines an analytical model with a phenomenologically based representation of the material's behavior, the so called ductile failure curve. ESA

N93-27484*# Auburn Univ., AL. Materials Engineering Program.
HOT HYDROGEN TESTING OF REFRACTORY METALS AND CERAMICS Final Report, 24 Feb. 1992 - 23 Feb. 1993
Ralph Zee, Bryan Chin, and Jon Cohron 23 Feb. 1993 119 p
(Contract NAS8-39131)
(NASA-CR-192560; NAS 1.26:192560) Avail: CASI HC A06/MF A02

The objective of this investigation is to develop a technique with

which refractory metal carbide samples can be exposed to hydrogen containing gases at high temperatures, and to use various microstructural and analytical techniques to determine the chemical and rate processes involved in hydrogen degradation in these materials. Five types of carbides were examined including WC, NbC, HfC, ZrC, and TaC. The ceramics were purchased and were all monolithic in nature. The temperature range investigated was from 850 to 1600 C with a hydrogen pressure of one atmosphere. Control experiments, in vacuum, were also conducted for comparison so that the net effects due to hydrogen could be isolated. The samples were analyzed prior to and after exposure. Gas samples were collected in selected experiments and analyzed using gas chromography. Characterization of the resulting microstructure after exposure to hydrogen was conducted using optical microscopy, x-ray diffraction, scanning electron microscopy, and weight change. The ceramics were purchased and were all monolithic in nature. It was found that all samples lost weight after exposure, both in hydrogen and vacuum. Results from the microstructure analyses show that the degradation processes are different among the five types of ceramics involved. In addition, the apparent activation energy for the degradation process is a function of temperature even within the same material. This indicates that there are more than one mechanism involved in each material, and that the mechanisms are temperature dependent. Author (revised)

N93-27530# National Inst. of Standards and Technology, Boulder, CO. Materials Reliability Div.

ALUMINUM ALLOYS FOR ALS CRYOGENIC TANKS: COMPARATIVE MEASUREMENTS OF CRYOGENIC MECHANICAL PROPERTIES OF Al-Li ALLOYS AND ALLOY 2219

R. P. Reed, P. T. Purtscher, N. J. Simon, J. D. McColskey, and R. P. Walsh Feb. 1993 147 p See also AD-A242956

(PB93-173441; NISTIR-3979) Avail: CASI HC A07/MF A02

Tensile and fracture toughness were obtained at cryogenic temperatures to compare the Al-Li alloys 8090, 2090, and WL049, and alloy 2219 in various tempers and specimen orientations. The strongest alloy at very low temperatures is WL049-T851, which is about 10 percent stronger than 2090-T81. Both alloys are considerably stronger than 2219-T87. Alloy 2090-T81 is tougher (about 50 percent) than WL049-T851 at low temperatures; the higher toughness is attributed to the presence of fewer constituent particles and the tendency to delaminate at low temperatures. The delamination divides the moving crack, thus separating it into smaller regions where plane stress (rather than plane strain) conditions are conducive to increased toughness. NTIS

N93-27624# Sandia National Labs., Albuquerque, NM.

WETTING OXIDIZED Fe, Ni, Co ALLOY WITH COPPER

L. C. Beavis, E. Roherty-Osmun, and M. B. Ritchey Jan. 1993 26 p

(Contract DE-AC04-76DP-00789)

(DE93-009604; SAND-90-2412) Avail: CASI HC A03/MF A01

Experiments were run to determine if oxidized Kovar could be chemically cleaned so that copper would wet the Kovar in a wet hydrogen atmosphere at 1100 C. We found that a multi-stepped acid etch process cleaned the Kovar so that copper would wet it. We also found that the degree of copper cracking after melting and cool-down correlated well with the degree of wetting. DOE

N93-27647# State Univ. of New York, Stony Brook. Dept. of Materials Science and Engineering.

A SURFACE ANALYTICAL INVESTIGATION OF THE INFLUENCE OF SULPHATE REDUCING BACTERIA ON METALLIC CORROSION Final Report, 15 Dec. 1991 - 14 Dec. 1992

Clive R. Clayton 12 Mar. 1993 7 p

(Contract N00014-92-J-1550)

(AD-A262357) Avail: CASI HC A02/MF A01

It has long been recognized that Sulphate Reducing Bacteria (SRB) found in natural and industrial waste waters promote Microbiologically Influenced Corrosion (MIC) of certain metals and alloys. X-ray Photoelectron Spectroscopy (XPS) is used in conjunction with conventional microbiological and quantitative chemical analytical techniques to better understand the effect of environmental conditions on microbial behavior as well as the ability of SRB to alter local environmental conditions (such as pH) in such a way as to accelerate corrosion. Specifically, the interactions of Fe, Cr, Ni, and Mo ions with Desulfovibrio sp. under anoxic conditions were studied in order to determine the resulting speciation of the metal ions and sulfur. DTIC

N93-27660# Carnegie-Mellon Univ., Pittsburgh, PA. Dept. of Materials Science and Engineering.

FUNDAMENTALS OF MECHANICAL BEHAVIOR IN INTERMETALLIC COMPOUNDS Final Report, 1 Oct. 1989 - 30 Sep. 1992

James M. Howe and Anthony W. Thompson 1 Feb. 1993 15 p

(AD-A262443; AFOSR-93-0178TR; MEMS-ALC-16) Avail: CASI HC A03/MF A01

This research program has examined mechanical behavior and creep of titanium aluminide alloys, both based on Ti3Al and TiAl, with the goal being better understanding of relationships between microstructure and mechanical properties of these intermetallic compound-based alloys. Detailed microstructural characterization has been conducted for both types of aluminide alloys. For Ta additions to TiAl alloys, which are thought to improve ductility, lowered stacking fault energy and increased twinning have been found. For a Ti3Al-based alloy, detailed stress and temperature dependences of creep have been measured, and a strong microstructural dependence of creep properties has been established. DTIC

N93-27674# Pratt and Whitney Aircraft, West Palm Beach, FL. Government Engines and Space Propulsion.

FATIGUE IN SINGLE CRYSTAL NICKEL SUPERALLOYS Technical Progress Report, 16 Sep. 1991 - 15 Sep. 1992

Daniel P. DeLuca and Charles Annis 15 Mar. 1993 5 p

(Contract N00014-91-C-0124)

(AD-A262126; PW/GESP-FR21998-17) Avail: CASI HC A01/MF A01

This program investigates the seemingly unusual behavior of single crystal airfoil materials. The fatigue initiation processes in single crystal (SC) materials are significantly more complicated and involved than fatigue initiation and subsequent behavior of a (single) macrocrack in conventional, isotropic, materials. To understand these differences it is helpful to review the evolution of high temperature airfoils. Characteristics of Single Crystal Materials: Modern gas turbine flight propulsion systems employ single crystal materials for turbine airfoil applications because of their superior performance in resisting creep, oxidation, and thermal mechanical fatigue (TMF). These properties have been achieved by composition and alloying, of course, but also by appropriate crystal orientation and associated anisotropy. DTIC

N93-27682# Army Materials Technology Lab., Watertown, MA.

TUNGSTEN ALLOY TECHNOLOGY Final Report

Robert J. Dowding, ed. Jan. 1993 85 p Presented at the International Conference on Tungsten and Tungsten Alloys, Arlington, VA, 16-18 Nov. 1992

(AD-A262184; ARL-MR-57) Avail: CASI HC A05/MF A01

The papers collected here represent contributions to the International Conference on Tungsten and its Alloys in which Materials Directorate personnel had primary or secondary authorship responsibility. The conference was held in Arlington, VA, 16-18 November 1992. These papers are indicative of the present interests of the Army in tungsten alloys for kinetic energy penetrator applications. The papers are compiled in alphabetical order, according to the last name of the first author listed. DTIC

N93-27877# Technische Univ., Delft (Netherlands). Heat Treatment Science and Technology Div.

PRECIPITATION PHENOMENA IN ALUMINIUM-BASED METAL MATRIX COMPOSITES: EFFECTS OF REINFORCEMENT ON KINETICS AND MISFIT ACCOMMODATION Ph.D. Thesis

Marco Jan Starink 1992 169 p Sponsored by Netherlands Foundation for Technological Sciences

(ETN-93-93604) Avail: CASI HC A08/MF A02

A number of publications concerning the heat treatment of Metal Matrix Composites (MMC's) produced via Rapid Solidification Processing (RSP) techniques are presented. Two types of RSP MMC's were studied. The Al-1.3at Cu-19at Si alloy was produced via melt spinning, while the Al-20at Si-1.5at Cu-1at Mg (ASCM) alloys reinforced with varying contents of Al2O3 particles were produced via gas atomization and subsequent mixing with Al2O3. Both alloys were finally compacted by hot extrusion. In all alloys,a high percentage (about 20 vol. %) of silicon particles are present. Due to RSP, these particles are spherically shaped and finely dispersed in the

matrix, with an average size of 4 micrometers. In addition to these Si particles, the reinforced ASCM alloys contained up to 10 vol. % of irregularly shaped Al2O3 particles with sizes ranging from 1 to 6 micrometers and an average aspect ratio of 2. The alloys were studied by x-ray diffraction, differential scanning calorimetry (DSC), hardness measurements, and optical microscopy. ESA

N93-27921# Army Armament Research, Development and Engineering Center, Watervliet, NY.
MATERIAL ANALYSIS OF AUSTEMPERED DUCTILE IRON Final Report
Sandra O. Roy and Kathryn E. Noll Jan. 1993 17 p
(AD-A261953; ARCCB-TR-93003) Avail: CASI HC A03/MF A01

A materials analysis was performed on a sample of austempered ductile iron (ADI). This material was supplied in the heat-treated condition by a commercial producer. ADI is being examined as a potential alternate material to be used in the manufacture of muzzle brakes and other candidate weapon components. The analysis included mechanical property determination, chemical composition determination, metallographic examination, and scanning electron microscopy. The mechanical properties obtained were compared to the requirements specified on the 155-mm M284 muzzle brake drawing and the military casting specification MIL-B-12253. Based on the analysis, the ADI material examined would not be suitable as an alternate material for the muzzle brake. Furthermore, the results of the evaluation suggest that the material may not have been property heat treated for this particular application. DTIC

N93-28010# Pacific Northwest Lab., Richland, WA.
THE COMPLEX ACTION OF MAJOR SOLUTES ON RADIATION INDUCED SWELLING OF Fe-Cr-Ni AUSTENITIC ALLOYS
F. A. Garner, T. Lauritzen (General Electric Co., Sunnyvale, CA.), and M. A. Mitchell (Illinois Univ., Urbana.) Jun. 1992 14 p Presented at the 16th Annual Symposium of American Society of Testing and Materials (ASTM) on Effects of Radiation on Materials, Denver, CO, 21-25 Jun. 1992
(Contract DE-AC06-76RL-01830)
(DE93-007994; PNL-SA-19952; CONF-920673-17) Avail: CASI HC A03/MF A01

The radiation-induced swelling of simple Fe-Cr-Ni austenitic alloys is sensitive to solute additions. It is shown that three of the most common solute elements (P,Si,Mo) exert a very complex and often non-monotonic influence on swelling with increasing solute level. The complexity of this influence and its dependence on other variables appears to be the result of a closely balanced competition between two or more roles played by each solute in its interaction with both vacancies and interstitials. This competition yields a variety of different swelling behaviors in response to changes in solute or solvent composition, displacement rate, and irradiation temperature. DOE

N93-28071*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
STRESS CORROSION EVALUATION OF HP 9Ni-4Co-0.20C STEEL
Pablo D. Torres Washington Jun. 1993 46 p
(NASA-TP-3384; M-722; NAS 1.60:3384) Avail: CASI HC A03/MF A01

A stress corrosion cracking (SCC) evaluation was undertaken on HP 9Ni-4Co-0.20C steel in support of the Advanced Solid Rocket Motor (ASRM) program. This alloy was tested in plate, bar, and ring forging forms. Several heat treating procedures yielded ultimate tensile strengths ranging from 1,407 to 1,489 MPa (204 to 216 ksi). The test environments were high humidity, alternate immersion in 3.5-percent NaCl, and 5-percent salt spray. Stress levels ranged from 25 to 90 percent of the yield strengths. The majority of the tests were conducted for 90 days. Even though the specimens rusted significantly in salt spray and alternate immersion, no failures occurred. Therefore, it can be concluded that this alloy, in the forms and at the strength levels tested, is highly resistant to SCC in salt and high humidity environments. Author (revised)

N93-28148# EG and G Rocky Flats, Inc., Golden, CO.
APPLICATIONS OF MOLTEN SALTS IN REACTIVE METALS PROCESSING
B. Mishra (Colorado School of Mines, Golden.), D. L. Olson (Colorado School of Mines, Golden.), and W. A. Averill 1993 12 p Presented at the Engineering Foundation Conference, Miami, FL, 16 Mar. 1993
(Contract DE-AC34-90DP-62349)
(DE93-003368; RFP-4651; CONF-930366-1) Avail: CASI HC A03/MF A01

Pyrochemical processes using molten salts provide a unique opportunity for the extraction and refining of many reactive and valuable metals either directly from the beneficiated ore or from other process effluent that contain reactive metal compounds. This research program is aimed at developing a process for the production and recovery of reactive and valuable metals, such as zinc, tin, lead, bismuth, and silver, in a hybrid reactor combining electrolytic production of the calcium reductant and in-situ utilization of this reductant for pyrochemical reduction of the metal compounds, such as halide or oxides. The process is equally suitable for producing other low melting metals, such as cadmium and antimony. The cell is typically operated below 1000 C temperature. Attempts have been made to produce silver, lead, bismuth, tin, and cerium by calciothermic reduction in a molten salt media. In a separate effort, calcium has been produced by an electrolytic dissociation of lime in a calcium chloride medium. The most important characteristic of the hybrid technology is its ability to produce metals under 'zero-waste' conditions. DOE

N93-28228# California Inst. of Tech., Pasadena. Div. of Engineering and Applied Science.
MARTENSITIC PHASE TRANSITIONS WITH SURFACE EFFECTS
Mark T. Lusk Jun. 1992 45 p
(Contract N00014-90-J-1871)
(AD-A262886; TR-8) Avail: CASI HC A03/MF A01

A model of martensitic phase transitions is presented that is capable of accounting for a variety of surface effects associated with the localized interaction of coexisting phases of a material. Such phenomena are thought to play a critical role in determining the size, shape, and stability of nucleated embryos as well as to affect the conditions under which nucleation occurs. Attention is restricted to transitions that are mechanically induced, and the model can not account for temperature effects. Materials that undergo martensitic phase changes are modeled as hyperelastic in both the bulk and the interface. The characterization of such bodies is examined in detail, and a representation theorem is presented for isotropic, hyperelastic interfaces in terms of two scalar invariants associated with the deformation of the interface. DTIC

N93-28232# Lawrence Livermore National Lab., CA.
ELECTRONIC STRUCTURE THEORY OF ALLOY PHASE STABILITY
P. E. A. Turchi and M. Sluiter 24 Aug. 1992 8 p Presented at the 2nd International Conference and Exhibition on Computer Applications to Materials and Molecular Science and Engineering, Yokohama, Japan, 22-25 Sep. 1992
(Contract W-7405-eng-48)
(DE93-009547; UCRL-JC-109658; CONF-920927-2) Avail: CASI HC A02/MF A01

We present a brief overview of the advanced methodology which has been developed and applied to the study of phase stability properties in substitutional alloys. The approach is based on the real space version of the Generalized Perturbation Method within the Korringa-Kohn-Rostoker multiple scattering formulation of the Coherent Potential Approximation. Temperature effects are taken into account with a generalized meanfield approach, namely the Cluster Variation Method, or with Monte-Carlo simulations. We show that this approach is well suited for studying ground state properties of substitutional alloys, for calculating energies of idealized interfaces and antiphase boundaries, and finally to compute alloy phase diagrams. DOE

N93-28234# Southwest Research Inst., San Antonio, TX.
APPLICATION OF MAGNETOMECHANICAL HYSTERESIS MODELING OF MAGNETIC TECHNIQUES FOR MONITORING NEUTRON EMBRITTLEMENT AND BIAXIAL STRESS
M. J. Sablik, H. Kwun, and G. L. Burkhardt 31 Jan. 1993 44 p
(Contract DE-FG05-91ER-14180)
(DE93-009760; DOE/ER-14180/3) Avail: CASI HC A03/MF A01

Research was done on the biaxial stress problem accomplished in the first half of the second year. All of the work done was preparatory to magnetic measurements. Issues addressed were as follows: construction of a model for extracting changes in the magnetic properties of a specimen from the readings of an indirect sensor; initial development of a model for

how biaxial stress alters the intrinsic magnetic properties of the specimen; use of finite element stress analysis modeling to determine a detailed shape for the cruciform biaxial stress specimen; and construction of the biaxial stress loading apparatus. DOE

N93-28253*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

STRESS CORROSION EVALUATION OF HP 9Ni-4Co-0.30C STEEL PLATE WELDS

Pablo D. Torres Washington May 1993 62 p

(NASA-TP-3376; M-721; NAS 1.60:3376) Avail: CASI HC A04/MF A01

A stress corrosion cracking (SCC) investigation was conducted on HP 9Ni-4Co-0.30C steel plate welds (welded by using straight polarity plasma arc and HP 9Ni-4Co-0.20C weld wire) since this material is being considered for use in the Advanced Solid Rocket Motor (ASRM) program. Prior to the welding, the material was double tempered at 538 C (1,000 F). After welding, only part of the material was stress relieved at 510 C (950 F) for 3 h. Round tensile specimens obtained from nonstress-relieved material were tested in 100-percent relative humidity at 38 C (100 F), in 3.5-percent NaCl alternate immersion, and in 5-percent salt spray at 35 C (95 F). Specimens obtained from stress-relieved material were tested in alternate immersion. The stress levels were 50, 75, and 90 percent of the corresponding 0.2-percent yield strength (YS). All the nonstress-relieved specimens exposed to salt spray and alternate immersion failed. Stress-relieved specimens (exposed to alternate immersion) failed at 75 and 90 percent of YS. No failures occurred at 50 percent of YS in the stress-relieved specimens which indicates a beneficial effect of the stress relief on the SCC resistance of these welds. The stress relief also had a positive effect on the mechanical properties of the welds (the most important being an increase of 21 percent on the YS). Under the conditions of these tests, the straight polarity plasma are welded HP 9Ni4Co-0.30C steel plate was found highly susceptible to SCC in the nonstress-relieved condition. This susceptibility to SCC was reduced by stress relieving.

Author (revised)

N93-28362# Lehigh Univ., Bethlehem, PA.

HIGH RESOLUTION MICROSTRUCTURAL AND MICROCHEMICAL ANALYSIS OF ZIRCONIA EUTECTIC INTERFACES

M. R. Notis 17 Mar. 1993 10 p

(Contract DE-FG02-84ER-45150)

(DE93-010971; DOE/ER-45150/8) Avail: CASI HC A02/MF A01

Resolution of microscopic analytical methods has greatly improved over the past decade, and it is now possible to examine periodic variations in structure and chemistry at a scale much finer than the spacing typical of eutectic structures (1-5 microns). During the current year, studies were completed on ZrO2-NiO and ZrO2-MnO eutectic systems, and study was initiated on microchemical variation in two spinodal systems: Cu-Ni-Sn and SnO2-TiO2. Work was also initiated on metal/oxide interface microchemistry, in particular the corrosion interface resulting during oxidation of Cu-Sn alloys. DOE

N93-28371# Lawrence Livermore National Lab., CA. Condensed Matter Div.

ORDERING AND DISPLACIVE TRANSFORMATIONS IN Ni-Al ALLOYS

M. Sluiter and P. E. A. Turchi 19 Oct. 1992 7 p Presented at the NATO Advanced Study Institute on Statics and Dynamics of Alloy Phase Transformations, Rhodes, Greece, 21 Jun. - 3 Jul. 1992

(Contract W-7405-eng-48)

(DE93-009553; UCRL-JC-112102; CONF-9206202-6) Avail: CASI HC A02/MF A01

It has been shown that the framework of Korringa-Kohn-Rostoker Coherent Potential Approximation Generalized Perturbation Method (KKR-CPA-GPM) can describe with good accuracy phase equilibria in the Ni-Al system. The stability of the Ni5Al3 phase is explained and its relation to the martensitic transformation is discussed. The sequence of transformations upon cooling from the B2 phase was rationalized with a displacive process occurring first and followed by a secondary ordering reaction. The order-disorder tendencies in Ni3Al are in excellent agreement with experimental data, and the exceptional stability of the NiAl phase is correctly predicted. Moreover, the first-principles method predicts the occurrence of an ordered Ni5Al3 phase which closely resembles the experimentally observed structure. DOE

N93-28410*# Vanderbilt Univ., Nashville, TN. Center for Materials Tribology.

NUCLEATION AND GROWTH OF ROLLING CONTACT FAILURE OF 440C BEARING STEEL Final Report, 1 Aug. 1991 - 31 Oct. 1992

V. Gupta, P. C. Bastias, G. T. Hahn, and C. A. Rubin 27 Dec. 1992 64 p

(Grant NAG8-205)

(NASA-CR-193138; NAS 1.26:193138) Avail: CASI HC A04/MF A01

A 'two-body' elasto-plastic finite element model of 2-dimensional rolling and rolling-plus-sliding was developed to treat the effect of surface irregularities. The model consists of a smooth cylinder in contact with a semi-infinite half-space that is either smooth or fitted with one of 0.4 microns deep or 7 microns deep groove, or a 0.4 microns high ridge-like asperity. The model incorporates elastic-linear-kinematic hardening-plastic (ELKP) and non-linear-kinematic hardening-plastic (NLKP) material constitutive relations appropriate for hardened bearing steel and the 440C grade. The calculated contact pressure distribution is Hertzian for smooth body contact, and it displays intense, stationary, pressure spikes superposed on the Hertzian pressure for contact with the grooved and ridged surface. The results obtained for the 0.4 microns deep groove compare well with those reported by Elsharkawy and Hamrock for an EHD lubricated contact. The effect of translating the counterface on the half space as opposed to indenting the half space with the counter face with no translation is studied. The stress and strain values near the surface are found to be similar for the two cases, whereas they are significantly different in the subsurface. It is seen that when tiny shoulders are introduced at the edge of the groove in the finite element model, the incremental plasticity and residual stresses are significantly higher in the vicinity of the right shoulder (rolling direction is from left to right) than at the left shoulder. This may explain the experimental observation that the spall nucleation occurs at the exit end of the artificially planted indents. Pure rolling calculations are compared with rolling + sliding calculations. For a coefficient of friction, mu = 0.1, the effect of friction is found to be small. Efforts were made to identify the material constitutive relations which best describe the deformation characteristics of the bearing steels in the initial few cycles. Elastic-linear-kinematic hardening-plastic (ELKP) material constitutive relations produce less net plastic deformation in the initial stages for a given stress, than seen in experiments. A new set of constitutive relations: non-linear-kinematic hardening-plastic (NLKP) was used. This material model produces more plasticity than the ELKP model and shows promise for treating the net distortions in the early stages. Techniques for performing experimental measurements that can be compared with the finite element calculations were devised. The measurements are being performed on 9mm-diameter, 440C steel cylindrical rolling elements in contact with 12.5 mm-diameter, 52100 steel balls in a 3-ball-rod fatigue test machine operating at 3600 RPM. Artificial, 7 microns deep, indents were inserted on the running track of the cylindrical rolling elements and profilometer measurements of these indents made, before and after the rolling. These preliminary measurements show that the indents are substantially deformed plastically in the process of rolling. The deformations of the groove calculated with the finite element model are comparable to those measured experimentally. Author

N93-26686*# Arizona Univ., Tucson. Strategic Metals Recovery Research Facility.

RECOVERY AND SEPARATION OF PRECIOUS METALS FROM SPACE

H. Freiser and S. Muralidharan *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 3 p (For primary document see N93-26674 10-91)

Avail: CASI HC A01/MF A03; 1 functional color page

N93-28271*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

SURFACE CHARACTERIZATION OF SELECTED LDEF TRAY CLAMPS

T. F. Cromer (Virginia Polytechnic Inst. and State Univ., Blacksburg.), H. L. Grammer (Virginia Polytechnic Inst. and State Univ., Blacksburg.), J. P. Wightman (Virginia Polytechnic Inst. and State Univ., Blacksburg.), Philip R. Young, and Wayne S. Slemp *In its* LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 1015-1022 (For primary document see N93-28254 10-99)

(Grant NAG1-1186)

Avail: CASI HC A02/MF A04; 2 functional color pages

27 NONMETALLIC MATERIALS

Includes physical, chemical, and mechanical properties of plastics, elastomers, lubricants, polymers, textiles, adhesives, and ceramic materials.

For composite materials see *24 Composite Materials.*

N93-26611# California Univ., Berkeley. Lawrence Berkeley Lab.
MAGNETIC THIN FILMS AND NANOSTRUCTURES: ANISOTROPY, MICROSTRUCTURE, AND THEIR INTER-RELATIONSHIP
K. M. Krishnan Oct. 1992 11 p Presented at the Microstructures of Materials Conference, Berkeley, CA, 22-23 Oct. 1992
(Contract DE-AC03-76SF-00098)
(DE93-007714; LBL-33106; CONF-9210311-1) Avail: CASI HC A03/MF A01

Magnetic thin films and nanostructures exhibit novel properties and have great technological potential. In particular, developing thin film structures with perpendicular anisotropy, understanding the underlying mechanisms, and identifying meaningful microstructure-property relationships in such nanometer scale materials is an ongoing challenge. Here, two different approaches, as well as details of the relevant microstructure, are presented. DOE

N93-26638# Stone and Webster Engineering Corp., Boston, MA.
EVALUATION OF CERAMIC TUBES, JOINTS, AND SEALS FOR HIGH PRESSURE HEAT EXCHANGE SYSTEMS Annual Report, 1 Sep. 1991 - 31 Aug. 1992
J. J. Williams Jan. 1993 28 p
(Contract GRI-5090-298-2096)
(PB93-173490; GRI-93/0058) Avail: CASI HC A03/MF A01

Silicon carbide containing ceramics were evaluated for their use as reactor tubes in a steam-methane reformer. Screening tests, using ceramic coupons exposed to simulated syngas mixtures at up to 1900 F, have shown that at high temperatures, steam partial pressure is an important parameter in the extent of steam attack on the silicon carbide. However, there are operating conditions, e.g., steam partial pressures below 60 PSIA, which will minimize the extent of silicon carbide attack. Further testing of coupons and tubular shapes is planned at Oak Ridge National Laboratory and at the Center for Advanced Materials at Pennsylvania State University. NTIS

N93-26672# Oak Ridge National Lab., TN.
STRUCTURE PROPERTY RELATIONSHIPS OF NANOMETER SIZE METAL CLUSTERS IN GLASSES
R. H. Magruder, III, D. L. Kinser, J. E. Wittig, and R. A. Zuhr 1992 11 p Presented at the Society of Photo-Optical Instrumentation Engineers (SPIE) International Symposium on Optical Applied Science and Engineering, San Diego, CA, 19-24 Jul. 1992
(Contract DE-AC05-84OR-21400)
(DE93-007922; CONF-920792-47) Avail: CASI HC A03/MF A01

Ion implantation of Cu in high purity silica has been used to produce nanometer size metallic copper clusters. The size and size distribution of these colloids have been characterized by quantitative images analysis emphasizing transmission electron microscopy. Electron diffraction patterns indicate they are crystalline FCC copper embedded in the amorphous silica host. The ion implantation dose and substrate temperatures alter the size distribution of the colloidal copper. The optical transmission of implanted silica containing varying sizes and size distributions of Cu clusters has been determined and is related to the size distribution. DOE

N93-26942# Kansas Univ. Center for Research, Inc., Lawrence.
IMPROVING RESERVOIR CONFORMANCE USING GELLED POLYMER SYSTEMS
D. W. Green and P. G. Willhite 25 Dec. 1992 6 p
(Contract DE-AC22-92BC-14881)
(DE93-010078; DOE/BC-14881/1) Avail: CASI HC A02/MF A01

The general objectives are (1) to identify and develop gelled polymer systems which have potential to improve reservoir conformance of fluid displacement processes, (2) to determine the performance of these systems in bulk and in porous media, and (3) to develop methods to predict the capability of these systems to recover oil from petroleum reservoirs. This work focuses on three types of gel systems -- an aqueous polysaccharide (KUSP1) system that gels as a function of pH, the chromium-based system where polyacrylamide and xanthan are crosslinked by Cr(III) and an organic crosslinked system. Development of the KUSP1 system and evaluation and identification of the organic crosslinked system are conducted. The laboratory research is directed at the fundamental understanding of the physics and chemistry of the gelation process in bulk form and in porous media. This knowledge is used to develop conceptual and mathematical models of the gelation process. Mathematical models are then extended to predict the performance of gelled polymer treatments in oil reservoirs. Progress reports are presented for the following tasks: Development and selection of gelled polymer systems; physical and chemical characterization of gel systems; and mathematical modelling of gel systems. DOE

N93-27006*# Cleveland State Univ., OH.
INTERACTIVE RELIABILITY MODEL FOR WHISKER-TOUGHENED CERAMICS Final Report
Joseph L. Palko (Cleveland State Univ., OH.) Apr. 1993 48 p
(Contract NCC3-81; RTOP 778-32-11)
(NASA-CR-191048; E-7513; NAS 1.26:191048) Avail: CASI HC A03/MF A01

Wider use of ceramic matrix composites (CMC) will require the development of advanced structural analysis technologies. The use of an interactive model to predict the time-independent reliability of a component subjected to multiaxial loads is discussed. The deterministic, three-parameter Willam-Warnke failure criterion serves as the theoretical basis for the reliability model. The strength parameters defining the model are assumed to be random variables, thereby transforming the deterministic failure criterion into a probabilistic criterion. The ability of the model to account for multiaxial stress states with the same unified theory is an improvement over existing models. The new model was coupled with a public-domain finite element program through an integrated design program. This allows a design engineer to predict the probability of failure of a component. A simple structural problem is analyzed using the new model, and the results are compared to existing models. Author

N93-27050# Argonne National Lab., IL. Materials and Components Technology Div.
FRICTION AND WEAR PERFORMANCE OF ION-BEAM DEPOSITED DIAMONDLIKE CARBON FILMS ON STEEL SUBSTRATES
A. Erdemir, F. A. Nichols, X. Z. Pan, R. Wei, and P. Wilbur Jan. 1993 22 p Presented at the 3rd International Conference on the New Diamond Science and Technology and 3rd European Conference on Diamond, Diamond-Like and Related Coatings, Heidelberg, Germany, 31 Aug. - 4 Sep. 1992
(Contract W-31-109-eng-38)
(DE93-007896; ANL/MCT/CP-75881; CONF-920854-2) Avail: CASI HC A03/MF A01

In this study, we investigated the friction and wear performance of ion-beam-deposited diamondlike-carbon (DLC) films (1.5 (mu)m thick) on AISI 440C steel substrates. Furthermore, we ran a series of long-duration wear tests under 5, 10, and 20 N load to assess the load-bearing capacity and durability limits of these films under each load. Tests were performed on a ball-on-disk machine in open air at room temperature approximately 22 +/- 1 C, and humidity, approximately 30 +/- 5%. For the test conditions explored, we found that (1) the steady-state friction coefficients of pairs without a DLC film were in the range of 0.7 to 0.9 and the average wear rates of 440C balls (9.55 mm diameter) sliding against uncoated 440C disks were on the order of 10(exp -5) mm(exp 3)/N*m, depending on contact load; (2) DLC films reduced the steady-state friction coefficients of test pairs by factors of 6 to 8, and the wear rates of pins by factors of 500 to 2000; (3) the wear of disks coated with a DLC film was virtually unmeasurable while the wear of uncoated disks was quite substantial; (4) these DLC films were able to endure the range of loads, 5 to 20 N, without any delamination and to last over a million cycles before wearing out. During long-duration wear tests, the friction coefficients were initially on the order of 0.15, but decreased to some low values of 0.05 to 0.07 after sliding for 15 to 25 km, depending on the load, and remained low until wearing out. This low-friction regime was correlated with the formation of a carbon-rich transfer film on the wear scar of 440C balls. Micro-laser-Raman spectroscopy and scanning-electron microscopy were used to examine the structure and chemistry of worn surfaces and to

elucidate the wear- and friction-reducing mechanisms of the DLC film. DOE

N93-27052# Brookhaven National Lab., Upton, NY.
DEPOSITION AND MODIFICATION OF TANTALUM CARBIDE COATINGS ON GRAPHITE BY LASER INTERACTIONS
J. Veligdan, D. Branch, P. E. Vanier, and R. E. Barletta 1992 7 p Presented at the 16th Material Research Society International Symposium on the Scientific Basis for Nuclear Waste Management Fall Meeting, Boston, MA, 30 Nov. - 5 Dec. 1992
(Contract DE-AC02-76CH-00016)
(DE93-008055; BNL-48492; CONF-921101-93) Avail: CASI HC A02/MF A01

Graphite surfaces can be hardened and protected from erosion by hydrogen at high temperatures by refractory metal carbide coatings, which are usually prepared by chemical vapor deposition (CVD) or chemical vapor reaction (CVR) methods. These techniques rely on heating the substrate to a temperature where a volatile metal halide decomposes and reacts with either a hydrocarbon gas or with carbon from the substrate. For CVR techniques, deposition temperatures must be in excess of 2000 C in order to achieve favorable deposition kinetics. In an effort to lower the bulk substrate deposition temperature, the use of laser interactions with both the substrate and the metal halide deposition gas has been employed. Initial testing, involved the use of a CO2 laser to heat the surface of a graphite substrate and a KrF excimer laser to accomplish a photodecomposition of TaCl5 gas near the substrate. Results of preliminary experiments using these techniques are described. DOE

N93-27125*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
METALLURGY AND PROPERTIES OF PLASMA SPRAY FORMED MATERIALS
T. N. McKechnie (Rockwell International Corp., Huntsville, AL.), Y. K. Liaw (Rockwell International Corp., Huntsville, AL.), F. R. Zimmerman, and R. M. Poorman 1992 9 p Repr. from Thermal Spray: International Advances in Coatings Technology p 839-845 Proceedings of the International Thermal Spray Conference held in Orlando, FL, 28 May - 5 Jun. 1992
(NASA-TM-108269; NAS 1.15:108269; SAN-204-7586) Avail: CASI HC A02/MF A01

Understanding the fundamental metallurgy of vacuum plasma spray formed materials is the key to enhancing and developing full material properties. Investigations have shown that the microstructure of plasma sprayed materials must evolve from a powder splat morphology to a recrystallized grain structure to assure high strength and ductility. A fully, or near fully, dense material that exhibits a powder splat morphology will perform as a brittle material compared to a recrystallized grain structure for the same amount of porosity. Metallurgy and material properties of nickel, iron, and copper base alloys will be presented and correlated to microstructure. Author

N93-27400# National Inst. of Standards and Technology, Gaithersburg, MD. Ceramics Div.
CERAMICS TECHNICAL ACTIVITIES, 1992 (NAS-NRC ASSESSMENT PANEL, 13-14 MAY 1993)
S. W. Freiman 1992 222 p
(PB93-173508; NISTIR-4964) Avail: CASI HC A10/MF A03

In 1992 the Ceramics Division continued to develop a technical program which addresses the needs of U.S. industry. The program is made up of tasks involving standard materials development, construction of evaluated databases, and laboratory research focused on topics relevant to the dominant issues affecting commercialization of advanced ceramics, e.g., processing costs and reliability. Some areas of research were: data activities; powder characterization; surface properties; mechanical properties; electronic materials; optical materials; and materials microstructure characterization. NTIS

N93-27523# Argonne National Lab., IL. Materials and Components Technology Div.
SYNERGISTIC EFFECTS OF SILVER FILMS AND SYNTHETIC LUBRICANTS ON BOUNDARY-LUBRICATION BEHAVIOR OF CERAMICS
A. Erdemir, O. O. Ajayi, R. A. Erck, G. R. Fenske, F. A. Nichols, J. M. Ockers (Illinois Univ., Urbana.), K. K. Kar, and T. A. Morgan Nov. 1992 22 p Presented at the 1992 Coatings for Advanced Heat Engines Workshop, Monterey, CA, 2 Aug. 1992
(Contract W-31-109-eng-38)
(DE93-007895; ANL/MCT/CP-76367; CONF-9208207-1) Avail: CASI HC A03/MF A01

In a study seeking to achieve low friction and low wear on ceramic materials, we investigated a new lubrication concept that explores the synergistic effect of a silver film and a recently developed synthetic oil on the boundary lubrication behavior of silicon nitride (Si3N4) ceramics. Friction and wear tests were performed on a wear test machine at temperatures up to 380 C. Under the test conditions explored, we found that the friction coefficients of Si3N4/Si3N4 test pairs during oil-lubricated sliding tests ranged from 0.1 to 0.35, and the average wear rates of ceramic pins were between 3 x 10(exp -7) and 10(exp -6) mm(exp 3) N(sup -1) m(sup -1), depending on test temperature. Concurrent use of lubricant oil with a silver film had a synergistic effect on both friction and wear. When silver films are used at oil-lubricated sliding interfaces, wear rates of both pins and flats were reduced to unmeasurable levels and the friction coefficients were reduced by factors of two to ten below those of the test pairs without silver films. Beneficial synergistic effects of silver films and synthetic oil on the boundary-lubrication behavior of ceramics were more pronounced at elevated test temperatures than at room temperature. DOE

N93-27616# California Univ., Berkeley. Lawrence Berkeley Lab.
SOL-GEL PREPARATION OF ION-CONDUCTING CERAMICS FOR USE IN THIN FILMS Ph.D. Thesis
M. I. Steinhauser Dec. 1992 108 p
(Contract DE-AC03-76SF-00098)
(DE93-007720; LBL-33364) Avail: CASI HC A06/MF A02

A metal alkoxide sol-gel solution suitable for depositing a thin film of La(0.6)Sr(0.4)CoO(3) on a porous substrate has been developed; such films should be useful in fuel cell electrode and oxygen separation membrane manufacture. Crack-free films have been deposited on both dense and porous substrates by dip-coating and spin-coating techniques followed by a heat treatment in air. Fourier transform infrared spectroscopy was used to determine the chemical structure of metal alkoxide solution system. X-ray diffraction was used to determine crystalline phases formed at various temperatures, while scanning electron microscopy was used to determine physical characteristics of the films. Surface coatings have been successfully applied to porous substrates through the control of the substrate pore size, deposition parameters, and firing parameters. Conditions have been defined for which films can be deposited, and for which the physical and chemical characteristics of the film can be improved. A theoretical discussion of the chemical reactions taking place before and after hydrolysis in the mixed alkoxide solutions is presented, and the conditions necessary for successful synthesis are defined. Applicability of these films as ionic and electronic conductors is discussed. DOE

N93-27622# Los Alamos National Lab., NM.
EXTRACTION CHROMATOGRAPHY OF NEODYMIUM BY AN ORGANOPHOSPHOROUS EXTRACTANT SUPPORTED ON VARIOUS POLYMERIC RESINS
D. Y. Takigawa Apr. 1993 10 p
(Contract W-7405-eng-36)
(DE93-009113; LA-12026-MS) Avail: CASI HC A02/MF A01

Fifteen resins coated with dihexyl-N,N-diethylcarbamoyl methylphosphonate (CMP) were studied for their extraction of neodymium (Nd) in 4.0 and 7.0 M nitric acid. Resin properties, such as chemical composition and physical morphology, which can influence Nd extraction as well as subsequent resin regeneration (Nd stripping), were identified. Hydrophilic or polar resins coated with CMP efficiently extracted the Nd. Resins initially washed free of residual monomer and solvent before CMP coating outperformed their untreated counterparts. The macroporous styrene-divinylbenzene hydrophobic resins that were high in surface area were less effective supports compared with hydrophilic microporous Aurorez, polybenzimidazole (PBI) and macroporous Amberlite polyacrylic resins. Only one resin, Duolite C-467, showed no measurable improvement in Nd extraction with CMP coating. CMP-coated Aurorez PBI, a microporous and hydrophilic polymeric resin with an average surface area, showed the best overall efficiency for Nd removal and resin regeneration. DOE

N93-27651# Case Western Reserve Univ., Cleveland, OH. Dept. of Macromolecular Science.

THE STUDY OF FIBER-MATRIX INTERACTIONS VIA FT-IR MICROSCOPY AND NMR IMAGING

A. Mavrich, F. Fondeur, H. Ishida, J. L. Koenig, and D. H. Wagner (Weizmann Inst. of Science, Rehovoth, Israel.) Mar. 1993 24 p

(Contract N00014-92-J-1590)

(AD-A262326; CWRU/DMS/TR-48) Avail: CASI HC A03/MF A01

Model composites of Kevlar-49 and D-glass fiber/epoxy systems were analyzed using NMR imaging and FT-IR microscopy. The surfaces of both reinforcing agents were found to significantly affect the curing process of the epoxy. The NMR images reveal an accelerated rate of cure in the proximity of the fibers as compared to the bulk, indicating strong interactions between the fibers and the matrices. To spectroscopically characterize these interactions, FT-IR microscopy was performed on Kevlar reinforced microcomposites. Transmission spectra and IR functional group images reveal a preferential segregation of the epoxy resin to the fiber surface. Thin films of epoxy resin deposited on single Kevlar filaments were also examined using FT-IR microscopy. Spectra and IR images from these samples suggest that the amine group of the Kevlar fiber is reacting with the epoxide ring of the resin to catalyze the curing process. DTIC

N93-27655# Minnesota Univ., Minneapolis. Dept. of Chemical Engineering and Materials Science.

STM TIP-INDUCED TRANSITIONS OF DISLOCATION NETWORK STRUCTURES ON THE SURFACE OF HIGHLY ORIENTED PYROLYTIC GRAPHITE Technical Report, 30 Jun. 1992 - 31 Mar. 1993

Shelly R. Snyder, William W. Gerberich, and Henry S. White 20 Mar. 1993 40 p

(Contract N00014-91-J-1927)

(AD-A262419; TR-9) Avail: CASI HC A03/MF A01

Scanning tunneling microscopy observations of a reversible, tip-induced transition between triangular- and star-shaped networks of partial dislocations on the basal (0001) plane of highly oriented pyrolytic graphite (HOPG) are reported. The transition between network geometries results from small variations (0.14 V) in the tip-to-substrate voltage bias and is attributed to shear-induced motion of partial dislocations. The shear stress required for the transition is estimated to be 5 MPa. Dislocation motion occurs over distances of tens of nanometers on the time scale of several minutes, allowing the dynamics of the transition between the two networks to be observed in real time. Atomically resolved images near a dislocation show distortions of the atomic lattice that are consistent with glide of the surface basal plane. Analysis of the separation distance between pairs of dislocations yields a surface stacking fault energy of 2.14.5 mJ/m2. DTIC

N93-27669# Nebraska Univ., Lincoln. Dept. of Chemistry.

ORIENTATIONAL PAIR CORRELATION, POLAR ORDER PARAMETER AND TEMPORAL STABILITY IN THE SECOND HARMONIC GENERATION OF AMORPHOUS POLYMERS

S. S. Gong, T. Goodson, III, H. W. Guan, and C. H. Wang 1993 21 p

(Grant NSF DMR-91-12993)

(AD-A262013; TR-19) Avail: CASI HC A03/MF A01

Measurements of the second harmonic generation (SHG) signal were made on the DAN/PMMA guest/host system as a function of the nonlinear optical (NLO) chromophore concentration and the poling field strength. The temporal stability of the SHG signal, after the poling field was removed, was also investigated. The polar orientational order parameters, L-33 and L-31, were deduced from the second order nonlinear susceptibility. Both of the polar orientational order parameters and the relaxation time of the nonlinear susceptibility were found to increase with increasing NLO chromophore concentration. The concentration dependence was interpreted as due to the anisotropic intermolecular interaction, particularly the dipole-dipole interaction. The anisotropic intermolecular interaction introduces the orientational pair correlation function which enhances the polar order as well as the temporal stability of the NLO effect. DTIC

N93-27697# Michigan Univ., Ann Arbor. Dept. of Materials Science and Engineering.

TAILORED ORGANOMETALLIC POLYMERS Final Report, May 1989 - Oct. 1992

Richard M. Laine, Christopher Viney, and Robert J. Corriu 31 Jan. 1993 131 p

(Contract F49620-89-C-0059)

(AD-A262446; AFOSR-93-0168TR) Avail: CASI HC A07/MF A02

Molecular tailoring concepts were applied to the synthesis of novel inorganic and organometallic polymers, many of them starting from commonly available polymorphs of SiO2 (beach sand). Liquid crystalline molecular order was identified in random co-oligomers and copolymers of bis(catecholato) spirosiloxanes. Factors affecting the nature and distribution of microstructural defects in liquid crystalline materials were identified with a view to minimizing the scattering of light as it passes through such materials. DTIC

N93-27914# Aerospace Corp., El Segundo, CA. Technology Operations.

LUBRICANTS FOR HIGH-VACUUM APPLICATIONS

M. R. Hilton and P. D. Fleischauer 15 Mar. 1993 64 p

(Contract F04701-88-C-0089)

(AD-A263026; TR-0091(6945-03)-6; SMC-TR-93-14) Avail: CASI HC A04/MF A01

This report reviews the selection criteria and performance of lubricants in vacuum environments found in terrestrial equipment and in (and around) space vehicles. Vacuum, mechanical, and thermal conditions of such lubricant use are outlined. Tribology issues are defined that should be considered in initial design of systems used in terrestrial equipment or space vehicles. The types of vacuum lubricants that are available (dry or solid, liquid, or grease) are reviewed, their properties and applicability to general situations are assessed, and the option of not lubricating is discussed. Examples of specific applications and performance data for lubricants in space and on earth are presented. DTIC

N93-27945# Technische Univ., Delft (Netherlands). Solid State Div.

BISMUTH BASED CERAMIC SUPERCONDUCTORS: AN EXPERIMENTAL STUDY ON CRYSTAL GROWTH AND VORTEX DYNAMICS Ph.D. Thesis

Jacobus Hendrikus Pe Emmen 1992 127 p Sponsored by Stichting voor Fundamenteel Onderzoek der Materie, Netherlands

(ETN-93-93665) Avail: CASI HC A07/MF A02

Crystal growth and vortex dynamics of bismuth based ceramic superconductors are investigated. Crystal growth of high temperature superconductors by means of the Traveling Solvent Floating Zone (TSFZ) technique is reported. The two systems Bi2Sr2Ca(n-1)Cu(n)O(2n+4+z) with n1 and n2 (denoted as Bi-n 1, 2) were investigated. Plate-like crystals of Bi-n 1 were obtained with the TSFZ technique although specific annealing experiments failed to introduce bulk superconductivity. The TSFZ method appears to be suitable for growth of Bi-n 2 single crystals. The vortex dynamics of the grown Bi-n 2 crystals are studied, focusing on magnetic manifestations. Of prime interest was to test various flux dynamics models and to determine the pin potential. It appears that the response of the vortex lattice to a small alternating field superimposed onto a large DC field can be described by the Thermally Activated Flux Flow (TAFF) model as long as the temperature at which the maximum of the AC losses appears does not depend on the amplitude of the ripple field. ESA

N93-28006# Lawrence Livermore National Lab., CA.

PROVIDING ADHERENT COATINGS ON TUNGSTEN AND TUNGSTEN ALLOYS

J. W. Dini Oct. 1992 8 p Presented at the 4th International Seminar on Battery Waste Management, Deerfield Beach, FL, 9-11 Nov. 1992

(Contract W-7405-eng-48)

(DE93-007505; UCRL-JC-111965; CONF-921158-3) Avail: CASI HC A02/MF A01

Application of adherent coatings on tungsten can be problematic because of the tenacious, natural oxide surface film that forms on this substrate. However, by combining the technologies of physical vapor deposition and electroplating, dense, adherent coatings can be obtained on tungsten. Quantitative ring shear and conical head data are used to support this recommendation. Quantitative data are also included for a wet chemical etching procedure that is effective for preparing tungsten-nickel-iron alloy for plating. DOE

N93-28007# Sandia National Labs., Albuquerque, NM.

X RAY REFLECTIVITY MEASUREMENTS OF VACUUM DEPOSITED THIN FILMS

M. Chason (Motorola, Inc., Schaumburg, IL.) and E. Chason 1992 8 p Presented at the Motorola 1993 Winter Advanced Manufacturing Technologies Symposium, Phoenix, AZ, 23-24 Feb. 1993
(Contract DE-AC04-76DP-00789)
(DE93-007579; SAND-92-2541C; CONF-930262-1) Avail: CASI HC A02/MF A01

X-ray reflectivity using energy dispersive X-ray detection, a nondestructive probe of surface roughness over the region of approximately 1-50 A, has been used to investigate the characteristics of vacuum deposited thin films. With a surface roughness sensitivity better than 1 A, x-ray reflectivity is sensitive to interfaces between different materials for sample thicknesses up to approximately 2000 A (depending on material density). We have investigated discrete Cr/Al deposits on quartz substrates and determined the surface roughness at the interfaces. We have also monitored the evolution of the Cr/Al interface following annealing. The experimental data is presented and discussed. The use of the technique for studying thin film deposits is addressed. DOE

N93-28117# Maxdem, Inc., San Dimas, CA.
A NEW CLASS OF HIGH STRENGTH MOLDING RESINS, PHASE 1 Status Report, 15 - 31 Mar. 1993
Mark Trimmer 31 Mar. 1993 5 p
(Contract MDA972-93-C-0029; ARPA Order 7755)
(AD-A262691) Avail: CASI HC A01/MF A01

Maxdem has developed a novel family of thermoplastic resins, designated Poly-X(TM), which demonstrate exceptional strength and modulus. PolyX(TM) is based on a new type of rigid-rod polymer structure which combines good mechanical properties with facile processibility. Therefore, parts can be molded from Poly-X(TM) resins by a variety of common molding techniques and are projected to possess ultra-high mechanical strength and stiffness. Composites fabricated with Poly-X(TM) resins are expected to have unprecedented compressive strengths due to the high modulus of the Poly-X(TM) matrix resin. During the proposed Phase 1 work, initial experiments will be performed to demonstrate suitable fibermatrix adhesion for composite applications and that high strength parts can be molded. Work has begun to prepare the quantities of polymer required to perform these tasks and to fabricate test samples to allow evaluation of the fiber-resin interfacial properties. During the Phase 2 work, new composites will be fabricated which are projected to possess significantly enhanced compressive strength compared to the current state-of-the-art. DTIC

N93-28207# Sandia National Labs., Albuquerque, NM.
TENSILE PROPERTIES OF EPOXY ENCAPSULANTS
T. R. Guess, K. B. Wischmann, and M. E. Stavig Feb. 1993 42 p
(Contract DE-AC04-76DP-00789)
(DE93-008494; SAND-92-2768) Avail: CASI HC A03/MF A01

Tensile properties were measured for nineteen different formulations of epoxy encapsulating materials. Formulations were of different combinations of two neat resins (Epon 828 and Epon 826, with and without CTBN modification), three fillers (ALOX, GNM, and mica), and four hardeners (Z, DEA, DETDA-SA, and ANH-2). Five of the formulations were tested at -55, -20, 20, and 60C; one formulation at -55, 20, and 71C; and the remaining formulations at 20C. Complete stress-strain curves are presented along with tables of tensile strength, initial modulus, and Poisson's ratio. The stress-strain responses are nonlinear and are temperature dependent. The reported data provide information for comparing the mechanical properties of encapsulants containing the suspected carcinogen Shell Z with the properties of encapsulants containing noncarcinogenic hardeners. Also, calculated shear moduli, based on measured tensile moduli and Poisson's ratio, are in very good agreement with reported shear moduli from experimental torsional pendulum tests. DOE

N93-28218# Naval Research Lab., Washington, DC.
ION-BEAM-ASSISTED DEPOSITION OF WEAR-RESISTANT COATINGS
B. D. Sartwell and R. A. Kant 1993 7 p
(Contract DE-AI02-88CE-90024)
(DE93-011525; DOE/CE-90024/7) Avail: CASI HC A02/MF A01

Chromium oxide coatings were deposited using the IBAD technique onto single crystal silicon substrates. Their friction and wear behavior was tested by sliding them against either a 52100 steel ball or a silicon nitride ball. Microhardness tests resulted in values of approximately 1900 KHN for the coatings, 1300 KHN for bare silicon, and 750 for bare 52100. In sliding against the 52100 ball, no loss of material or deformation of the coating was observed. For sliding against the silicon nitride ball, in the absence of the coating a deep wear scar was observed. However, with the coating, virtually no wear was detected, indicating almost complete protection. A new microwave ion source was interfaced with a UHV vacuum chamber, providing a new IBAD system. Several TiN coatings were produced, and their mechanical properties are currently being evaluated. DOE

N93-28219# Northwestern Univ., Evanston, IL.
DEPOSITION AND PROPERTIES OF NOVEL NITRIDE SUPERLATTICE COATINGS
S. A. Barnett, W. D. Sproul, and M. S. Wong Apr. 1993 12 p
(Contract DE-FG02-90ER-45434)
(DE93-011532; DOE/ER-45434/3) Avail: CASI HC A03/MF A01

We have carried out detailed studies of the processing, structure, and properties of certain polycrystalline superlattice coatings, including TiN/NbN, TiN/VN, TiN/Ni, and TiN/NiCr. The coatings were produced using an opposed, dual-cathode, high-rate, reactive, unbalanced-magnetron sputtering system. The coatings exhibited hardness values as high as 5200 kgf/sq mm for TiN/NbN, 5100 for TiN/VN, 3500 for TiN/Ni, and 3200 for TiN/NiCr. These hardness values are all twice higher than their corresponding rule-of-mixture hardness values. The structure and properties of the coatings are a strong function of superlattice period, partial pressure of N2, and energy and flux of ion bombardment during deposition. Possible mechanisms for hardness enhancement in the polycrystalline superlattice appear to be a result of dislocation blocking due to coherency strains, difference in dislocation line energies between layers, and small grain sizes. DOE

N93-28318# Oak Ridge National Lab., TN.
CHARACTERIZATION OF THERMAL ANNEALED Bi IMPLANTED SILICA
S. H. Morgan (Fisk Univ., Nashville, TN.), D. O. Henderson (Fisk Univ., Nashville, TN.), Z. Pan (Fisk Univ., Nashville, TN.), R. H. Magruder, III (Belmont Coll., Nashville, TN.), and R. A. Zuhr 1992 6 p Presented at the 16th Material Research Society International Symposium on the Scientific Basis for Nuclear Waste Management Fall Meeting, Boston, MA, 30 Nov. - 5 Dec. 1992
(Contract DE-AC05-84OR-21400)
(DE93-009712; CONF-921101-105) Avail: CASI HC A02/MF A01

Optical and infrared reflection spectra for Bi implanted silica are reported as a function of dose and thermal annealing. A series of high purity silica samples were implanted with Bi ions at an energy of 350 KeV. Doses were 1 x 10(exp 16) and 1.0 x 10(exp 17) ions/cm(exp 2) at 5 micro-amps/cm(exp 2). The samples were subsequently thermally annealed at 400, 600 and 800 C. The optical absorption from 6.2 to 1.8 eV and infrared reflectance from 5000 to 450/cm were measured before and after annealing. Effects of thermal annealing are strongly dependent on Bi content. DOE

N93-28345# Argonne National Lab., IL.
NANOPHASE MATERIALS ASSEMBLED FROM ATOM CLUSTERS
R. W. Siegel Dec. 1992 22 p Presented at the 4th NEC Symposium on Fundamental Approaches To New Material Phases: Physics and Chemistry of Nanometer-Scale Materials, Tokyo, Japan, 11-15 Oct. 1992
(Contract W-31-109-eng-38)
(DE93-005559; ANL/MSD/CP-76871; CONF-9210276-1) Avail: CASI HC A03/MF A01

Nanometer-scale atom clusters (with average diameters below 20 nm) of a variety of materials, including both metals and ceramics, have been synthesized by precursor evaporation and condensation in high-purity gases. The gas-entrained clusters can be collected and subsequently consolidated in situ under ultrahigh vacuum or other controlled atmosphere conditions to create bulk nanophase materials. These ultrafine-grained materials have properties that are often significantly different and considerably improved relative to those of their coarser-grained counterparts. The observed property changes relate to both their small grain sizes and the large percentage of their atoms in grain boundary environments. Since it is becoming apparent that their properties can be engineered during gas-phase synthesis and subsequent processing, nanophase materials assembled from atom clusters should have significant potential for technological development in a variety of applications. Some of the recent research on nanophase materials is reviewed. DOE

N93-28351# Ohio State Univ., Columbus. Dept. of Chemistry.
NEW CARBOHYDRATE-BASED MATERIALS Progress Report, 25 Sep. 1991 - 24 Nov. 1992
Matthew R. Callstrom Jul. 1992 6 p
(Contract DE-FG02-91ER-45463)
(DE93-011116; DOE/ER-45463/1) Avail: CASI HC A02/MF A01

We have prepared a series of new carbohydrate-based materials by using carbohydrates as a template for the introduction of functionality to polymeric materials with complete regio- and stereochemical control. The synthesis of these new materials by the use of chemical and enzymatic methods allows for the rational design of new materials based on the properties of the monomeric subunit. These materials have potential applications that range from their use in enhanced oil recovery to biodegradable plastics to biological applications including targeted drug delivery and enzyme stabilization. DOE

N93-28361# Montana State Univ., Bozeman. Dept. of Physics.
NMR AND OPTICAL STUDIES OF PIEZOELECTRIC POLYMERS
V. H. Schmidt and G. F. Tuthill 1993 5 p
(Contract DE-FG06-87ER-45292)
(DE93-010967; DOE/ER-45292/14) Avail: CASI HC A01/MF A01

Progress is reported in several areas dealing with piezoelectric (electroactive) polymers (mostly vinylidene fluoride, trifluoroethylene, copolymers, and PVF2) and liquid crystals. Optical studies, neutron scattering, NMR, thermal, theory, and modeling were done. DOE

N93-28364# Naval Research Lab., Washington, DC.
ION-BEAM-ASSISTED DEPOSITION OF WEAR-RESISTANT COATINGS Final Report, 1 Oct. 1988 - 31 Jan. 1993
B. D. Sartwell, R. A. Kant, and F. A. Smidt Feb. 1993 40 p
(Contract DE-AI02-88CE-90024)
(DE93-011120; DOE/CE-90024/14) Avail: CASI HC A03/MF A01

Both titanium nitride and chromium oxide coatings have been fabricated by ion-beam-assisted deposition, which involved the electron-beam evaporation of Ti or Cr and simultaneous bombardment with low-energy argon ions. Either nitrogen or oxygen gas was introduced into the deposition system from 1 to 8 x 10(exp -3) Pa to form the compound. Monitoring of the individual fluxes of vapor atoms, ions, and gas molecules incident on steel or Si substrates permitted control of deposition parameters, with the most critical one being ratio of incident argon ions to vapor atoms, R(sub ia). For both types of films, the hardness increased with this ratio. In scratch and sliding wear tests, both types of films demonstrated excellent adhesion to the substrates. For the TiN films, optimum wear resistance was obtained for R(sub ia) = 0.3 with a friction coefficient of 0.35 at Hertzian contact pressures in the range of 1 GPa. For the Cr2O3 films, optimum wear resistance was obtained for R(sub ia) = 0.1. At room temperature, no wear was observed for Si3N4 balls sliding on the coatings at contact pressures up to 1 GPa. At temperatures up to 500 C, virtually no wear was observed for sapphire balls sliding on the coatings at similar contact pressures. DOE

N93-28366# Naval Research Lab., Washington, DC.
ION BEAM ASSISTED DEPOSITION OF TRIBOLOGICAL COATINGS
R. A. Kant and F. A. Smidt 1993 12 p
(Contract DE-AI02-88CE-90024)
(DE93-011520; DOE/CE-90024/1) Avail: CASI HC A03/MF A01

The ion beam assisted deposition (IBAD) process provides a means of depositing adherent coatings at lower process temperatures than can be achieved by chemical vapor deposition (CVD). The present report reviews NRL experience in deposition TiN and Cr2O3 coatings and the evaluation of selected surface mechanical properties. The microstructure and properties of the TiN coating were found to be strongly influenced by processing conditions. Among the significant findings were the following observations: (1) the ion beam activates a process for conversion of adsorbed nitrogen to chemically bound nitrogen; (2) IBAD films produced at low ion to atom arrival rate ratios are soft and ductile, while those produced at arrival rate ratios of 0.3 to 0.4 are hard but still ductile; (3) all IBAD films are exceptionally adherent to steel substrates; and (4) the soft films are very fine grained (less than 10 nm) and have a network of pores at the grain boundaries. Experiments to optimize these films for advanced automotive applications are outlined. DOE

N93-28382# Massachusetts Inst. of Tech., Cambridge. Dept. of Chemical Engineering.
SELECTIVITY AND PERMEABILITY OF MICROPOROUS BLOCK COPOLYMER MEMBRANES Technical Report
D. H. Rein, R. F. Baddour, and R. E. Cohen 16 Apr. 1993 15 p
(Contract N00014-91-J-1045)
(AD-A263189; TR-9) Avail: CASI HC A03/MF A01

A selective solvent was used to develop a uniform microporous structure in a polystyrene - polymethylmethacrylate block copolymer. Pore diameters in the range of 200-500 angstroms were produced. Gas permeation measurements demonstrated a dramatic, five order of magnitude, increase in permeability coefficient associated with the throughgoing microporous structure. These high-flux membranes retained some selectivity for certain gas pairs as expected for transport based on Knudsen diffusion in the porous materials. DTIC

N93-28423*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
GUANIDINE BASED VEHICLE/BINDERS FOR USE WITH OXIDES, METALS, AND CERAMICS Patent Application
Warren H. Philipp, inventor (to NASA), Lisa C. Veitch, inventor (to NASA), and Martha H. Jaskowiak, inventor (to NASA) 25 Jun. 1993 14 p
(NASA-Case-LEW-15314-2; NAS 1.71:LEW-15314-2;
US-Patent-Appl-SN-081180) Avail: CASI HC A03/MF A01

The use of guanidine salts of organic fatty acids (guanidine soaps) as vehicles and binders for coating substrate surfaces is disclosed. Being completely organic, the guanidine soaps can be burned off leaving no undesirable residue. Of special interest is the use of guanidine 2-ethyl hexanoate as the vehicle and binder for coating problematic surfaces such as in coating alumina fibers with platinum or zirconia. For this application the guanidine soap is used as a melt. For other applications the guanidine soap may be used in a solution with a variety of solvents, the solution containing chlorometalates or powdered metals, refractories or ceramics. NASA

N93-28425*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
METHOD FOR RETARDING OXIDATION OF AN ORGANIC SUBSTRATE Patent Application
Bruce A. Banks, inventor (to NASA) and Sharon K. Rutledge, inventor (to NASA) 24 May 1993 15 p
(NASA-Case-LEW-15306-2; NAS 1.71:LEW-15306-2;
US-Patent-Appl-SN-065794) Avail: CASI HC A03/MF A01

Structures composed at least partially of an organic substrate are protected from oxidation by applying a catalyst onto said substrate for promoting the combination of atomic oxygen to molecular oxygen. The structure may also be protected by applying both a catalyst and an atomic oxygen shielding layer onto the substrate. The invention is useful for enhancing the protection of polymeric blankets, solar arrays, and spacecraft surfaces in low earth orbit from cavities produced by atomic oxygen. NASA

N93-28426*# National Aeronautics and Space Administration. Pasadena Office, CA.
DIAMOND COMPOSITE FILMS FOR PROTECTIVE COATINGS ON METALS AND METHOD OF FORMATION Patent Application
T. P. Ong, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) and Y. H. Shing, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) 22 Apr. 1993 20 p
(Contract NAS7-918)
(NASA-Case-NPO-18501-1-CU; NAS 1.71:NPO-18501-1-CU;
US-Patent-Appl-SN-052419) Avail: CASI HC A03/MF A01

Composite films consisting of diamond crystallites and hard amorphous films such as diamond-like carbon, titanium nitride, and titanium oxide are provided as protective coatings for metal substrates against extremely harsh environments. A composite layer having diamond crystallites and a hard amorphous film is affixed to a metal substrate via an interlayer including a bottom metal silicide film and a top silicon carbide film. The interlayer is formed either by depositing metal silicide and silicon carbide directly onto the metal substrate, or by first depositing an amorphous silicon film, then allowing top and bottom portions of the amorphous silicon to react during

deposition of the diamond crystallites, to yield the desired interlayer structure. NASA

N93-28431# Lawrence Livermore National Lab., CA.
EFFECT OF BINDERS ON THE DAMAGE THRESHOLD AND REFRACTIVE INDEX OF COATINGS PREPARED FROM COLLOIDAL SUSPENSIONS
I. M. Thomas Oct. 1992 10 p Presented at the SPIE Symposium on Boulder Damage, Boulder, CO, 28-30 Oct. 1992
(Contract W-7405-eng-48)
(DE93-009068; UCRL-JC-111520; CONF-9210295-4) Avail: CASI HC A02/MF A01

Addition of polyvinyl alcohol (PVA) to aqueous suspensions of AlOOH, ZrO2 and HfO2 has been found to increase the damage threshold and refractive index of coatings prepared from these suspensions. The increase in damage threshold may be due to the increase in coating strength brought about by the enhanced particle-to-particle bond strength due to the polymer binder. The binder also increases the refractive index by decreasing the porosity. This leads to a reduction in the number of layer pairs required for high reflection in a typical HR coating. A mirror consisting of only ten layer pairs of HfO2-SiO2 with PVA binder in the HfO2 had a reflectivity of over 99% at 1.06 microns and a damage threshold of 25-28 J/cm(sup 2) at 1.06 microns with a 10 ns pulse. DOE

N93-28436# Oak Ridge National Lab., TN.
OPTICAL BLEACHING OF BISMUTH IMPLANTED SILICA GLASS: A THRESHOLD EFFECT
S. Y. Park (Vanderbilt Univ., Nashville, TN.), R. H. Magruder, III (Vanderbilt Univ., Nashville, TN.), R. A. Weeks (Vanderbilt Univ., Nashville, TN.), and R. A. Zuhr 1992 9 p Presented at the 16th Material Research Society International Symposium on the Scientific Basis for Nuclear Waste Management Fall Meeting, Boston, MA, 30 Nov. - 5 Dec. 1992
(Contract DE-AC05-84OR-21400)
(DE93-009716; CONF-921101-106) Avail: CASI HC A02/MF A01

The near surface regions of high purity silica glass discs, Spectrosil A, were modified by implantation with bismuth ions at 160 keV and room temperature. The glasses implanted with a nominal dose of 6(10)(exp 16) Bi/sq cm at approximately 5 micro-A/sq cm were subsequently bleached with a 5.0 eV KrF pulsed excimer laser. The laser had an average pulse duration of approximately 20 ns and repetition rate of 10 Hz. It was found that the bleaching was dependent upon the power density of the laser for a constant total integrated energy. Ion backscattering and optical absorption measurements were made before and after laser irradiation. Large changes in optical density and depth distribution of the implanted ions were observed at power densities of greater than or equal to 45 mJ/sq cm-pulse. Onset of threshold for bleaching of silica glass implanted with 6(10)(exp 16) Bi/sq cm at 160 key and at room temperature is between 30 and 45 mJ/sq cm-pulse. DOE

N93-28437# Oak Ridge National Lab., TN.
WHEN ARE THIN FILMS OF METALS METALLIC?
E. W. Plummer (Tennessee Univ., Knoxville.) and P. A. Dowben (Syracuse Univ., NY.) Feb. 1993 17 p Presented at the 16th International Seminar on Surface Physics, Kudowa, Poland, 5 Oct. 1992
(Contract DE-AC05-84OR-21400)
(DE93-009718; CONF-9210335-1) Avail: CASI HC A03/MF A01

There is an increasing body of experimental information suggesting that very thin films of materials that are normally considered to be metals can exhibit behavior characteristic of a nonmetal. In almost all cases, there is a nonmetal-to-metal transition as a function of film density or thickness. This is frequently accompanied by a structural transition. Amazingly, this behavior seems to occur for metal films on metal substrates, as well as for metals on semiconductors. The identification of this phenomena and the subsequent explanation has been slow in developing due to the inability to directly measure the conductivity of a submonolayer film. This paper will discuss the evidence accumulated from a variety of spectroscopic experimental techniques for three systems: a Mott-Hubbard transition, a Peierls-like distortion, and a Wilson transition. DOE

N93-26685*# Arizona Univ., Tucson. Dept. of Materials Science and Engineering.
MELT-PROCESSING OF LUNAR CERAMICS
B. D. Fabes, W. H. Poisl, D. Allen, M. Minitti, S. Hawley, and T. Beck *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 12 p (For primary document see N93-26674 10-91)
Avail: CASI HC A03/MF A03

N93-27183 Rafael Armament Development Authority, Haifa (Israel). Materials and Processes Dept.
EPOXY ADHESIVES FOR FIELD REPAIR OF COMPOSITE STRUCTURES
H. Dodium and S. Kenig *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 144-148 (For primary document see N93-27166 10-01)
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N93-28259*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
LDEF POLYMERIC MATERIALS: 10 MONTHS VERSUS 5.8 YEARS OF EXPOSURE
Philip R. Young, Wayne S. Slemp, and Alice C. Chang (Lockheed Engineering and Sciences Co., Hampton, VA.) *In its* LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 827-847 (For primary document see N93-28254 10-99)
Avail: CASI HC A03/MF A04; 2 functional color pages

N93-28260*# Texas A&M Univ., College Station. Polymer Technology Center.
VISCOELASTIC CHARACTERIZATION OF THIN-FILM POLYMERS EXPOSED TO LOW EARTH ORBIT
Alan Letton, Allan Farrow, and Thomas Strganac *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 849-866 Sponsored in part by Rheometrics, Inc. (For primary document see N93-28254 10-99)
Avail: CASI HC A03/MF A04; 2 functional color pages

N93-28261*# Queensland Univ., Brisbane (Australia). Polymer Materials and Radiation Group.
A STUDY OF THE UV AND VUV DEGRADATION OF FEP
Graeme A. George, David J. T. Hill, James H. ODonnell, Peter J. Pomery, and Firas A. Rasoul *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 867-876 (For primary document see N93-28254 10-99)
Avail: CASI HC A02/MF A04; 2 functional color pages

N93-28267*# Grumman Aerospace Corp., Bethpage, NY.
AN XPS STUDY OF SPACE-EXPOSED POLYIMIDE FILM
Myung Lee, William Rooney, and James Whiteside *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 957-962 (For primary document see N93-28254 10-99)
Avail: CASI HC A02/MF A04; 2 functional color pages

N93-28275*# Boeing Defense and Space Group, Seattle, WA. Systems Special Investigation Group.
EVALUATION OF SEALS, LUBRICANTS, AND ADHESIVES USED ON LDEF
Harry Dursch, Bruce Keough, and Gary Pippin *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 1041-1060 (For primary document see N93-28254 10-99)
Avail: CASI HC A03/MF A04; 2 functional color pages

N93-28276*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
THE CONTINUING MATERIALS ANALYSIS OF THE THERMAL CONTROL SURFACES EXPERIMENT (S0069)
Donald R. Wilkes (AZ Technology, Huntsville, AL.), Edgar R. Miller (AZ Technology, Huntsville, AL.), James M. Zwiener, and Richard J. Mell *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 1061-1073 (For

primary document see N93-28254 10-99)
Avail: CASI HC A03/MF A04; 2 functional color pages

N93-28277*# Aerospace Corp., El Segundo, CA. Mechanics and Materials Technology Center.
THERMAL CONTROL PAINTS ON LDEF: RESULTS OF M0003 SUB-EXPERIMENT 18
C. H. Jaggers, M. J. Meshishnek, and J. M. Coggi *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 1075-1092 Sponsored in part by Wright Lab. (For primary document see N93-28254 10-99)
Avail: CASI HC A03/MF A04; 2 functional color pages

N93-28278*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
LDEF THERMAL CONTROL COATINGS POST-FLIGHT ANALYSIS
Wayne S. Slemp and Philip R. Young *In its* LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 1093-1097 (For primary document see N93-28254 10-99)
Avail: CASI HC A01/MF A04; 2 functional color pages

N93-28279*# Boeing Defense and Space Group, Seattle, WA.
SELECTED RESULTS FOR LDEF THERMAL CONTROL COATINGS
Johnny L. Golden *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 1099-1110 (For primary document see N93-28254 10-99)
Avail: CASI HC A03/MF A04; 2 functional color pages

N93-28280*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
FLUORESCENCE MEASUREMENTS OF THE THERMAL CONTROL EXPERIMENTS COATINGS ON LDEF S0069 AND A0114
J. M. Zwiener, R. J. Mell, P. N. Peters, J. C. Gregory (Alabama Univ., Huntsville.), D. R. Wilkes (AZ Technology, Huntsville, AL.), and E. R. Miller (AZ Technology, Huntsville, AL.) *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 1111-1123 (For primary document see N93-28254 10-99)
Avail: CASI HC A03/MF A04; 2 functional color pages

N93-28282*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
MONTE CARLO MODELING OF ATOMIC OXYGEN ATTACK OF POLYMERS WITH PROTECTIVE COATINGS ON LDEF
Bruce A. Banks, Kim K. deGroh, Bruce M. Auer, Linda Gebauer (Cleveland State Univ., OH.), and Jonathan L. Edwards (Cleveland State Univ., OH.) *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 1137-1150 (For primary document see N93-28254 10-99)
Avail: CASI HC A03/MF A04; 2 functional color pages

N93-28283*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
SECOND LDEF POST-RETRIEVAL SYMPOSIUM INTERIM RESULTS OF EXPERIMENT A0034
Roger C. Linton and Rachel R. Kamenetzky *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 1151-1168 (For primary document see N93-28254 10-99)
Avail: CASI HC A03/MF A04; 2 functional color pages

28 PROPELLANTS AND FUELS

Includes rocket propellants, igniters, and oxidizers; their storage and handling procedures; and aircraft fuels.

For related information see also *07 Aircraft Propulsion and Power, 20 Spacecraft Propulsion and Power,* and *44 Energy Production and Conversion.*

N93-26633# Gas Research Inst., Washington, DC. Strategic Planning and Analysis Div.
DESCRIPTION OF THE GLOBAL PETROLEUM SUPPLY AND DEMAND OUTLOOK UPDATED FOR THE 1993 EDITION OF THE GRI BASELINE PROJECTION OF US ENERGY SUPPLY AND DEMAND, DECEMBER 1992
D. A. Dreyfus and A. B. Koklauner Dec. 1992 21 p See also PB93-165751 and PB92-164292 LIMITED REPRODUCIBILITY: More than 20% of this document may be affected by microfiche quality
(PB93-165744; GRI-92/0547) Avail: CASI HC A03

Strategic planning of the research and development program carried out by Gas Research Institute (GRI) is supported by an annual GRI baseline projection of U.S. energy supply and demand. Because petroleum products compete in a wide variety of energy uses, oil prices serve as a market clearing force for the entire energy system. A significant portion of the U.S. petroleum supply is imported, and the price of crude oil to U.S. refiners is determined by the international oil trade. Any projection of the U.S. energy situation, therefore, requires the evaluation of the global oil market and the impact of oil price changes on the supply/demand balances of market participants. The 1992 edition of the projection completed in August 1991 assumed that in the aftermath of the war in the Middle East the fundamentals of oil trade would reassert their influence. This did indeed occur and with astonishing speed. In the face of this outlook, GRI has revised its 1993 oil price track downward. NTIS

N93-27666# Army Armament Research, Development and Engineering Center, Picatinny Arsenal, NJ. Armament Engineering Directorate.
THERMAL DECOMPOSITION OF ENERGETIC MATERIALS. 3: TEMPORAL BEHAVIORS OF THE RATES OF FORMATION OF THE GASEOUS PYROLYSIS PRODUCTS FROM CONDENSED-PHASE DECOMPOSITION OF 1,3,5-TRINITROHEXAHYDRO-S-TRIAZINE
Richard Behrens, Jr. and Suryanarayana Bulusu Feb. 1993 23 p LIMITED REPRODUCIBILITY: More than 20% of this document may be affected by microfiche quality
(AD-A261965; ARAED-SP-92003) Avail: CASI HC A03

Through the use of simultaneous thermogravimetry modulated beam mass spectrometry (STMBMS) measurements, time-of-flight (TOF) velocity-spectra analysis, and 2H, 13C, 15N, and 18O labeled analogues of 1,3,5-trinitrohexahydro- s-triazine (RDX), the thermal decomposition products of RDX have been identified as H2O, HCN, CO, CH2O, NO, N2O, NH2CHO, NO2, HONO, (CH3)NHCHO, oxy-s-triazine (OST), and 1 nitroso-3,5 dinitrohexahydro s-triazine (ONDNTA) and all of their gas formation rates have been measured as a function of time. From these results the primary reaction pathways that control the decomposition of RDX in both the solid and liquid phases have been discovered. Four primary reaction pathways control the decomposition of RDX in the liquid phase between 200 and 215 deg C. Two pathways are first-order reactions solely in RDX. One produces predominantly OST, NO, and H2O and accounts for approximately 30% of the decomposed RDX, and the other produces predominantly N2O and CH2O with smaller amounts of NO2, CO, and NH2CHO and accounts for 10% of the decomposed RDX. The third pathway consists of formation of ONDNTA by reaction between NO and RDX, followed by the decomposition of ONDNTA to predominantly CH2O and N2O. The fourth reaction pathway consists of decomposition of RDX through reaction with a catalyst that is formed from the decomposition products of previously decomposed RDX. ONDNTA is the only product that appears to be formed during the early stages of decomposition of RDX in the solid phase. DTIC

N93-28151# Sandia National Labs., Albuquerque, NM.
CALIBRATING THE BKW-EOS WITH A LARGE PRODUCT SPECIES DATA BASE AND MEASURED C-J PROPERTIES
M. L. Hobbs and M. R. Baer 1992 10 p Presented at the 10th Detonation Symposium, Boston, MA, Jul. 1992

(Contract DE-AC04-76DP-00789)
(DE93-007606; SAND-92-1931C; CONF-9207159-2) Avail: CASI HC A02/MF A01

The Becker-Kistiakowsky-Wilson equation of state (BKW-EOS) was calibrated over a wide initial density range near C-J states using measured detonation velocities, pressures, and temperatures from 62 explosives at 111 total initial densities. Values for the empirical BKW constants (alpha), (beta), (kappa), and (theta), were 0.5, 0.298, 10.5, and 6620, respectively. Values for the co-volume factors k(sub i), were assumed to be invariant. Model evaluation includes comparison to measured detonation properties from 91 explosives composed of combinations of Al, B, Ba, C, Ca, Cl, F, H, N, O, P, Pb, and Si at 147 total initial densities. Adequate agreement between predictions and measurements were obtained with a few exceptions. The exceptions were explosives which contained large amounts of aluminum, ammonium nitrate, barium nitrate, and silicon, as well as tetranitromethane and lead styphnate. However, detonation properties for the aluminum and nitrate containing explosives can be predicted adequately by assuming partial equilibrium. The performance of explosives containing large amounts of silicon can be predicted adequately by changing (beta) from 0.298 to 0.249. Performance of tetranitromethane and lead styphnate can also be predicted by adjusting (beta) and/or (kappa) slightly. DOE

N93-28296# Los Alamos National Lab., NM.
THE IMPORTANCE OF STERICALLY HINDERED SHEAR IN DETERMINING THE SENSITIVITY OF EXPLOSIVE CRYSTALS
J. J. Dick 1992 5 p Presented at the 16th Material Research Society International Symposium on the Scientific Basis for Nuclear Waste Management Fall Meeting, Boston, MA, 30 Nov. - 5 Dec. 1992
(Contract W-7405-eng-36)
(DE93-003861; LA-UR-92-3907; CONF-921101-12) Avail: CASI HC A01/MF A01

Sterically hindered shear in a plane shock wave in an explosive crystal is shown to be important in determining the shock sensitivity of pentaerythritol tetranitrate and nitromethane. The steric hindrance is analyzed at the intermolecular level in the unit cell, and compared to the experimental evidence. DOE

N93-26675*# Arizona Univ., Tucson. NASA Space Engineering Research Center.
PROPELLANT PRODUCTION AND USEFUL MATERIALS: HARDWARE DATA FROM COMPONENTS AND THE SYSTEMS
Kumar Ramohalli *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 19 p (For primary document see N93-26674 10-91)
Avail: CASI HC A03/MF A03; 1 functional color page

N93-27193 Technion - Israel Inst. of Tech., Haifa. Faculty of Aerospace Engineering.
PREDICTION OF PROPELLANT BEHAVIOR IN SPINNING FLOW OF A SPACE MOTOR Abstract Only
A. Gany, Y. Levy, and Y. M. Timnat *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 226-228 (For primary document see N93-27166 10-01)
Copyright Avail: Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel

N93-27217 Israel Military Industries, Ramat-Hasharon. Internal Ballistics Group.
COMPUTER-AIDED SURFACE REGRESSION ANALYSIS
David Horowitz *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 420-426 (For primary document see N93-27166 10-01)
Copyright Avail: Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel

N93-27969*# Arizona Univ., Tucson. NASA Space Engineering Resarch Center.
PROPELLANT PRODUCTION AND USEFUL MATERIALS: HARDWARE DATA FROM COMPONENTS AND THE SYSTEMS
Kumar Ramohalli *In its* Proceedings of the Lunar Materials Technology Symposium Feb. 1992 17 p (For primary document see N93-27956 10-91)
Avail: CASI HC A03/MF A03

29 MATERIALS PROCESSING

Includes space-based development of products and processes for commercial applications.

For biological materials see *55 Space Biology.*

N93-27011*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
A MULTI-ZONE MUFFLE FURNACE DESIGN
Neil D. Rowe and Martin Kisel (Analex Corp., Brook Park, OH.) May 1993 20 p
(RTOP 694-03-OC)
(NASA-TM-106153; E-7837; NAS 1.15:106153) Avail: CASI HC A03/MF A01

A Multi-Zone Muffle-Tube Furnace was designed, built, and tested for the purpose of providing an in-house experience base with tubular furnaces for materials processing in microgravity. As such, it must not only provide the desired temperatures and controlled thermal gradients at several discrete zones along its length but must also be capable of sustaining the rigors of a Space Shuttle launch. The furnace is insulated to minimize radial and axial heat losses. It is contained in a water-cooled enclosure for purposes of dissipating un-wanted residual heat, keeping the outer surfaces of the furnace at a 'touch-safe' temperature, and providing a rugged housing. This report describes the salient features of the furnace, testing procedures and results, and concluding remarks evaluating the overall design. Author

N93-28408*# Florida Univ., Gainesville. Dept. of Chemical Engineering.
RAPID THERMAL PROCESSING (RTP) OF SEMICONDUCTORS IN SPACE Progress Report, period ending 31 Mar. 1993
T. J. Anderson and K. S. Jones 1993 30 p Prepared in cooperation with Clarkson Univ., Potsdam, NY
(Grant NAG5-1809)
(NASA-CR-193110; NAS 1.26:193110) Avail: CASI HC A03/MF A01

The progress achieved on the project entitled 'Rapid Thermal Processing of Semiconductors in Space' for a 12 month period of activity ending March 31, 1993 is summarized. The activity of this group is being performed under the direct auspices of the ROMPS program. The main objective of this program is to develop and demonstrate the use of advanced robotics in space with rapid thermal process (RTP) of semiconductors providing the test technology. Rapid thermal processing is an ideal processing step for demonstration purposes since it encompasses many of the characteristics of other processes used in solid state device manufacturing. Furthermore, a low thermal budget is becoming more important in existing manufacturing practice, while a low thermal budget is critical to successful processing in space. A secondary objective of this project is to determine the influence of microgravity on the rapid thermal process for a variety of operating modes. In many instances, this involves one or more fluid phases. The advancement of microgravity processing science is an important ancillary objective. Author (revised)

N93-26950*# Alabama Univ., Huntsville. Center for Microgravity and Materials Research.
A COMPARISON OF LOW-GRAVITY MEASUREMENTS ON-BOARD COLUMBIA DURING STS-40
Melissa J. B. Rogers, C. R. Baugher, R. C. Blanchard (National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.), R. DeLombard (National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.), W. W. Durgin (Worcester Polytechnic Inst., MA.), D. H. Matthiesen (Case Western Reserve Univ., Cleveland, OH.), W. Neupert (National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.), and P. Roussel (European Space Research Lab., Noordwijk, Netherlands.) *In its* Acceleration Studies 18 Apr. 1993 20 p (For primary document see N93-26948 10-12)
Avail: CASI HC A03/MF A01

N93-27893*# Massachusetts Inst. of Tech., Cambridge. Space Engineering Research Center.
THE MIDDECK 0-GRAVITY DYNAMICS EXPERIMENT (MODE)
Edward F. Crawley and Javier deLuis *In its* Controlled Structures Technology Steering Committee Workshop 1992 27 p (For primary document see N93-27888 10-39)
Avail: CASI HC A03/MF A03

N93-27895*# Pretoria Univ. (South Africa).
MIDDECK 0-GRAVITY DYNAMICS EXPERIMENT: FLUID SLOSH EXPERIMENTS
Marthinus C. vanSchoor *In* MIT, Controlled Structures Technology Steering Committee Workshop 1992 27 p (For primary document see N93-27888 10-39)
Avail: CASI HC A03/MF A03

N93-27897*# Massachusetts Inst. of Tech., Cambridge. Space Engineering Research Center.
THE MIDDECK ACTIVE CONTROL EXPERIMENT: GRAVITY AND SUSPENSION EFFECTS
Edward F. Crawley, H. Alexander, and Daniel Rey *In its* Controlled Structures Technology Steering Committee Workshop 1992 18 p (For primary document see N93-27888 10-39)
Avail: CASI HC A03/MF A03

N93-28171*# Massachusetts Inst. of Tech., Cambridge.
MIDDECK 0-GRAVITY DYNAMICS EXPERIMENT (MODE)
Marthinus C. vanSchoor *In its* The 3rd Annual Controlled Structures Technology Symposium 1 Jul. 1991 23 p (For primary document see N93-28167 10-39)
Avail: CASI HC A03/MF A03

31 ENGINEERING (GENERAL)

Includes vacuum technology; control engineering; display engineering; cryogenics; and fire prevention.

N93-27229# Technische Univ., Eindhoven (Netherlands). Dept. of Electrical Engineering.
IDENTIFICATION FOR THE CONTROL OF MIMO INDUSTRIAL PROCESSES
A. C. P. M. Backx and A. A. H. Damen Dec. 1991 47 p
(EUT-91-E-256; ISBN-9-06-144256-7; ETN-93-93160) Avail: CASI HC A03/MF A01

A procedure for the identification of industrial processes with the intention of control system design is proposed. It is illustrated by an application to a full scale production process. The procedure was developed by directly meeting engineering constraints. The identification steps are motivated, keeping industrial applicability of the procedure in mind. The Multi Input Multi Output (MIMO) model set used is the common denominator form or minimum polynomial form. Parameter estimation is performed in several steps, thus adapting to estimation and control requirements. The proposed general scheme was successfully applied on various industrial applications. As an example of practical results obtained, the identification and control of a quartz tube glass process is described. ESA

N93-27517# National Inst. of Standards and Technology, Gaithersburg, MD. Computer Services Lab.
INTERNATIONAL SURVEY OF INDUSTRIAL APPLICATIONS OF FORMAL METHODS. VOLUME 1: PURPOSE, APPROACH, ANALYSIS, AND CONCLUSIONS
D. Craigen, S. Gerhart, T. Ralston, and K. Summerskill Mar. 1993 128 p See also PB93-178564 Sponsored by Atomic Energy Control Board and NRL
(PB93-178556; NIST/GCR-93/626-Vol-1) Avail: CASI HC A07/MF A02

Formal methods are mathematically-based techniques, often supported by reasoning tools, that can offer a rigorous and effective way to model, design and analyze computer systems. The purpose of the study is to evaluate international industrial experience in using formal methods. The cases selected are representative of industrial-grade projects and span a variety of application domains. The study had three main objectives: to better inform deliberations within industry and government on standards and regulations; to provide an authoritative record on the practical experience of formal methods to date; and to suggest areas where future research and technology development are needed. The volume is the first of a two volume, final report on an international survey of industrial applications of formal methods. It describes the study, the formal methods, the cases that were studied, the approach to performing the study, and the analysis, findings and conclusions. NTIS

N93-27518# National Inst. of Standards and Technology, Gaithersburg, MD. Computer Services Lab.
INTERNATIONAL SURVEY OF INDUSTRIAL APPLICATIONS OF FORMAL METHODS. VOLUME 2: CASE STUDIES
D. Craigen, S. Gerhart, T. Ralston, and K. Summerskill Mar. 1993 200 p See also PB93-178556 Sponsored by Atomic Energy Control Board and NRL
(PB93-178564; NIST/GCR-93/626-Vol-2) Avail: CASI HC A09/MF A03

Formal methods are mathematically-based techniques, often supported by reasoning tools, that can offer a rigorous and effective way to model, design and analyze computer systems. The purpose of the study is to evaluate international industrial experience in using formal methods. The cases selected are representative of industrial-grade projects and span a variety of application domains. The study had three main objectives: to better inform deliberations within industry and government on standards and regulations; to provide an authoritative record on the practical experience of formal methods to date; and to suggest areas where future research and technology development are needed. The volume is the second of a two volume, final report on an international survey of industrial applications of formal methods. It provides the details of the twelve case studies. For each of the case studies, it presents a case description, summarizes the information obtained (from interviews and the literature), provides an evaluation of the case, highlights R & D issues pertaining to formal methods and provides some conclusions. NTIS

N93-27528# Clemson Univ., SC. Dept. of Chemistry and Geology.
PHYSICAL PROPERTIES OF FLUORINATED PROPANE AND BUTANE DERIVATIVES AS ALTERNATIVE REFRIGERANTS
A. Beyerlein, D. DesMarteau, S. Hwang, N. Smith, and P. Joyner 1993 33 p
(Grant EPA-R-815134)
(PB93-173102; EPA/600/A-93/062) Avail: CASI HC A03/MF A01

The paper presents physical property measurements for 24 fluorinated propane and butane derivatives and one fluorinated ether which include melting point, boiling point, vapor pressure below the boiling point, heat of vaporization at the boiling point, critical properties (temperature and density), and liquid-phase heat capacities at 40 C. Measured vapor pressures are reported to the critical temperature for four of the compounds: HFC-227ea, HFC-245cb, HFC-236ea, and HFE-125a. These measured data, combined with estimated vapor-phase densities, heat capacities, and vapor pressures, may be used to evaluate the potentials of these chemicals as alternative refrigerants. Modified corresponding states methods, using HFC-134a as a reference fluid, are presented as a way to obtain the needed estimated data, and the accuracy of these methods is judged by comparisons with measured data. NTIS

N93-27545# Naval Postgraduate School, Monterey, CA.
THERMOELECTRIC COOLER DESIGN M.S. Thesis
William E. Clifton Dec. 1992 79 p
(AD-A262149) Avail: CASI HC A05/MF A01

Thermoelectric Cooler Design is a Microsoft Windows program to be used as an aid in the design of thermoelectric cooler devices. This program was written to be used to quickly model and compare alternative designs. A couple's optimum coefficient of performance and maximum heat pumping can be quickly determined. Other major features of the program include the ability to change material properties and dimensions of couples, analyze cascaded couples, and graph performance parameters. A brief description of thermoelectric cooler theory, modelling assumptions and complete source code listing is included. DTIC

N93-27726*# Michigan Univ., Ann Arbor. NASA Center for Space Terahertz Technology.

THE THIRD INTERNATIONAL SYMPOSIUM ON SPACE TERAHERTZ TECHNOLOGY: SYMPOSIUM PROCEEDINGS

1992 740 p Symposium held in Ann Arbor, Michigan, 24-26 Mar. 1992 Sponsored in cooperation with IEEE Prepared in cooperation with Jet Propulsion Lab., California Inst. of Tech., Pasadena

(Grant NAGw-1334)

(NASA-CR-193013; NAS 1.26:193013) Avail: CASI HC A99/MF A06

Papers from the symposium are presented that are relevant to the generation, detection, and use of the terahertz spectral region for space astronomy and remote sensing of the Earth's upper atmosphere. The program included thirteen sessions covering a wide variety of topics including solid-state oscillators, power-combining techniques, mixers, harmonic multipliers, antennas and antenna arrays, submillimeter receivers, and measurement techniques. For individual titles, see N93-27727 through N93-27785.

N93-27727*# Millitech Corp., South Deerfield, MA.

COHERENT SYSTEMS IN THE TERAHERTZ FREQUENCY RANGE: ELEMENTS, OPERATION, AND EXAMPLES **c32**

Paul F. Goldsmith *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 1-23 Prepared in cooperation with Five-College Astronomy Dept., Amherst, MA (For primary document see N93-27726 10-31)

Avail: CASI HC A03/MF A06

The topics are presented in viewgraph form and include the following: terahertz coherent systems applications; a brief overview of selected components; radiometry and spectroscopy--astronomy; radiometry--aircraft all weather landing system; radiometry--atmospheric remote sensing; plasma diagnostics; communications; radar systems; and materials measurement and manufacturing process control. Derived from text

N93-27728*# California Univ., Santa Barbara. Dept. of Electrical and Computer Engineering.

BROADBAND MILLIMETER-WAVE GaAs TRANSMITTERS AND RECEIVERS USING PLANAR BOW-TIE ANTENNAS **c32**

Y. Konishi (Shimadzu Corp., Kyoto, Japan.), M. Kamegawa (Shimadzu Corp., Kyoto, Japan.), M. Case, R. Yu, M. J. W. Rodwell, R. A. York, and D. B. Rutledge (California Inst. of Tech., Pasadena.) *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 24-31 (For primary document see N93-27726 10-31)

(Grant AF-AFOSR-0394-89)

Avail: CASI HC A02/MF A06

We report broadband monolithic transmitters and receivers IC's for mm-wave electromagnetic measurements. The IC's use nonlinear transmission lines (NLTL) and sampling circuits as picosecond pulse generators and detectors. The pulses are radiated and received by planar monolithic bow-tie antennas, collimated with silicon substrate lenses and off-axis parabolic reflectors. Through Fourier transformation of the received pulse, 30-250 GHz free space gain-frequency measurements are demonstrated with an accuracy approximately = 0.17 dB, RMS.

Author (revised)

N93-27729*# Michigan Univ., Ann Arbor. NASA Center for Space Terahertz Technology.

ACTIVE CPW-FED SLOT ANTENNAS FOR POWER COMBINING APPLICATIONS **c32**

Brian K. Kormanyos and Gabriel M. Rebeiz *In its* The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 32-36 Sponsored in part by RADC (For primary document see N93-27726 10-31)

Avail: CASI HC A01/MF A06

We have combined integrated circuit antenna technology with microwave oscillator design to build an active slot-oscillator. The design is planar, does not require via holes and is compatible with monolithic transistor technology. The CPW-fed antenna impedance is calculated using a full-wave analysis technique. Slot-oscillators were built at 7, 13, and 22 GHz, and the predicted oscillation frequencies agree well with experiments. The design is easily scaled to millimeter-wave frequencies and can be extended to power combining arrays. Author

N93-27730*# California Univ., Los Angeles. Dept. of Electrical Engineering.

THE 2X2 QUASI-OPTICAL POWER COMBINER ARRAY AT 20 GHz **c33**

Shigeo Kawasaki and Tatsuo Itoh *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 37-44 (For primary document see N93-27726 10-31)

(Contract DAAL03-88-K-0005)

Avail: CASI HC A02/MF A06

Investigation of a power combiner made of two FET oscillators for an active array are reported. As an approach by a quasi-optical method, a two-dimensional planar array of strongly coupled oscillators by direct connection through a microstrip line is used. In-phase condition between the oscillators as well as in-phase condition of each radiation wave was accomplished by regulating length of feed microstrip lines. The radiation elements of 1 lambda-slot are embedded in a circuit ground plane. At an operation frequency of 20 GHz, in both H- and E-planes, reasonable sigma radiation patterns were obtained which have good agreement with theoretical patterns. Author

N93-27731*# California Univ., Los Angeles. Center for High Frequency Electronics.

MONOLITHIC MILLIMETER-WAVE DIODE ARRAY BEAM CONTROLLERS: THEORY AND EXPERIMENT **c33**

L. B. Sjogren, H.-X. L. Liu, F. Wang, T. Liu, W. Wu, X.-H. Qin, E. Chung, C. W. Domier, N. C. Luhmann, Jr., and J. Maserjian (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) et al *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 45-57 Sponsored in part by Northrop Corp.; DOE; and ARO (For primary document see N93-27726 10-31)

Avail: CASI HC A03/MF A06

In the current work, multi-function beam control arrays have been fabricated and have successfully demonstrated amplitude control of transmitted beams in the W and D bands (75-170 GHz). While these arrays are designed to provide beam control under DC bias operation, new designs for high-speed electronic and optical control are under development. These arrays will fill a need for high-speed watt-level beam switches in pulsed reflectometer systems under development for magnetic fusion plasma diagnostics. A second experimental accomplishment of the current work is the demonstration in the 100-170 GHz (D band) frequency range of a new technique for the measurement of the transmission phase as well as amplitude. Transmission data can serve as a means to extract ('de-embed') the grid parameters; phase information provides more complete data to assist in this process. Additional functions of the array beam controller yet to be tested include electronically controlled steering and focusing of a reflected beam. These have application in the areas of millimeter-wave electronic scanning radar and reflectometry, respectively.

Author

N93-27732*# Michigan Univ., Ann Arbor. NASA Center for Space Terahertz Technology.

A STUDY OF SUBTERAHERTZ HEMT MONOLITHIC OSCILLATORS **c33**

Youngwoo Kwon and Dimitris Pavlidis *In its* The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 58-72 (For primary document see N93-27726 10-31)

Avail: CASI HC A03/MF A06

A detailed study of monolithic InP-based HEMT oscillators for subterahertz operation is presented. InAlAs/InGaAs HEMT's have been optimized for high frequency operation and showed very high maximum oscillation frequencies (f(sub max)) of 310 GHz using offset self-aligned gamma-gate technology. Power characteristics of HEMT oscillators are reported. An oscillation power of more than 10 mW was evaluated by large-signal analysis at 320 GHz using HEMT's with f(sub max) = 450 GHz, V(sub br) = 10 V and a gate width (W(sub g)) of 8 x 22.5 microns. Oscillator topology studies showed that complex feedback schemes such as dual and active feedback enhance the negative resistance. Push-push oscillator designs based on harmonic signal generation can finally be used to overcome the frequency barrier imposed by f(sub max). Author

N93-27733*# Virginia Univ., Charlottesville. Semiconductor Device Lab.
VARACTOR DIODES FOR MILLIMETER AND SUBMILLIMETER WAVELENGTHS **c33**
Brian J. Rizzi, Jeffrey L. Hesler, Hasan Dossal, and Thomas W. Crowe *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 73-92 Sponsored in part by JPL (For primary document see N93-27726 10-31)
(Grant NSF ECS-87-20850)
Avail: CASI HC A03/MF A06

Whisker-contacted GaAs Schottky barrier varactor diodes are the most common high-frequency multiplier element in use today. They are inherently simple devices that have very high frequency response and have been used to supply local oscillator power for Schottky heterodyne receivers to frequencies approaching 700 GHz. This paper discusses the development of improved varactor diode technology for space based applications at millimeter and submillimeter wavelengths. Author

N93-27734*# Virginia Univ., Charlottesville. Semiconductor Device Lab.
A SCHOTTKY/2-DEG VARACTOR DIODE FOR MILLIMETER AND SUBMILLIMETER WAVE MULTIPLIER APPLICATIONS **c33**
W. C. B. Peatman, Thomas W. Crowe, M. Shur, and B. Gelmont *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 93-109 (For primary document see N93-27726 10-31)
(Contract N00014-90-J-4006; NSF ECS-87-20850; NSF ECS-91-13123)
Avail: CASI HC A03/MF A06

A new Schottky diode is investigated for use as a multiplier element in the millimeter and submillimeter wavelength regions. The new diode is based on the Schottky contact at the edge of a 2-dimensional electron gas (2-DEG). As a negative voltage is applied to the Schottky contact, the depletion layer between the Schottky contact and the 2-DEG expands and the junction capacitance decreases, resulting in a nonlinear capacitance-voltage characteristic. In this paper, we outline the theory, design, fabrication, and evaluation of the new device. Recent results include devices having cutoff frequencies of 1 THz and above. Preliminary multiplier results are also presented. Author

N93-27735*# Chalmers Univ. of Technology, Goeteborg (Sweden). Applied Electron Physics.
THERMIONIC EMISSION CURRENT IN A SINGLE BARRIER VARACTOR **c33**
Hans Hjelmgren, Jack East (Michigan Univ., Ann Arbor.), and Erik Kollberg *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 110-114 (For primary document see N93-27726 10-31)
Avail: CASI HC A01/MF A06

From I-V measurements on Single Barrier Varactors (SBV) at different temperatures we concluded that thermionic emission across the barrier of the actual device is mainly due to transport through the X band. The same structure was also modeled with a one-dimensional drift-diffusion model, including a 'boundary condition' for thermionic emission across the heterojunction interface. By including thermionic field emission through the top of the triangular barrier of a biased diode and the effect of a non-abrupt interface at the heterojunction, we obtained good agreement between the modeled and measured I-V characteristics. Author

N93-27736*# Chalmers Univ. of Technology, Goeteborg (Sweden). Millimeter Wave Group.
PROGRESS ON SINGLE BARRIER VARACTORS FOR SUBMILLIMETER WAVE POWER GENERATION **c33**
Svein M. Nilsen, Hans Groenqvist, Hans Hjelmgren, Anders Rydberg, and Erik L. Kollberg *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 115-133 Sponsored in part by Swedish National Board for Industrial and Technical Development (For primary document see N93-27726 10-31)
(Contract ESA-7898/88/NL/PB(SC))
Avail: CASI HC A03/MF A06

Theoretical work on Single Barrier Varactor (SBV) diodes, indicate that the efficiency for a multiplier has a maximum for a considerably smaller capacitance variation than previously thought. The theoretical calculations are performed, both with a simple theoretical model and a complete computer simulation using the method of harmonic balance. Modeling of the SBV is carried out in two steps. First, the semiconductor transport equations are solved simultaneously using a finite difference scheme in one dimension. Secondly, the calculated I-V, and C-V characteristics are input to a multiplier simulator which calculates the optimum impedances, and output powers at the frequencies of interest. Multiple barrier varactors can also be modeled in this way. Several examples on how to design the semiconductor layers to obtain certain characteristics are given. The calculated conversion efficiencies of the modeled structures, in a multiplier circuit, are also presented. Computer simulations for a case study of a 750 GHz multiplier show that InAs diodes perform favorably compared to GaAs diodes. InAs and InGaAs SBV diodes have been fabricated and their current vs. voltage characteristics are presented. In the InAs diode, was the large bandgap semiconductor AlSb used as barrier. The InGaAs diode was grown lattice matched to an InP substrate with InAlAs as a barrier material. The current density is greatly reduced for these two material combinations, compared to that of GaAs/AlGaAs SBV diodes. GaAs based diodes can be biased to higher voltages than InAs diodes. Author

N93-27737*# Helsinki Univ. of Technology, Espoo (Finland). Radio Lab.
EFFECT OF COOLING ON THE EFFICIENCY OF SCHOTTKY VARACTOR FREQUENCY MULTIPLIERS AT MILLIMETER WAVES **c33**
Jyrki Louhi, Antti Raiesanen, and Neal Erickson (Five-College Astronomy Dept., Amherst, MA.) *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 134-145 (For primary document see N93-27726 10-31)
Avail: CASI HC A03/MF A06

The efficiency of the Schottky diode multiplier can be increased by cooling the diode to 77 K. The main reason for better efficiency is the increased mobility of the free carriers. Because of that the series resistance decreases and a few dB higher efficiency can be expected at low input power levels. At high output frequencies and at high power levels, the current saturation decreases the efficiency of the multiplication. When the diode is cooled the maximum current of the diode increases and much more output power can be expected. There are also slight changes in the I-V characteristic and in the diode junction capacitance, but they have a negligible effect on the efficiency of the multiplier. Author (revised)

N93-27738*# Michigan Univ., Ann Arbor. Solid State Electronics Lab.
SUPERLATTICE BARRIER VARACTORS **c33**
C. Raman, J. P. Sun, W. L. Chen, G. Munns, J. East, and G. Haddad *In its* The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 146-157 (For primary document see N93-27726 10-31)
(Contract DAAL03-87-K-0007)
Avail: CASI HC A03/MF A06

SBV (Single Barrier Varactor) diodes have been proposed as alternatives to Schottky barrier diodes for harmonic multiplier applications. However, these show a higher current than expected. The excess current is due to X valley transport in the barrier. We present experimental results showing that the use of a superlattice barrier and doping spikes in the GaAs depletion regions on either side of the barrier can reduce the excess current and improve the control of the capacitance vs. voltage characteristic. The experimental results consist of data taken from two types of device structures. The first test structure was used to study the performance of AlAs/GaAs superlattice barriers. The wafer was fabricated into 90 micron diameter mesa diodes and the resulting current vs. voltage characteristics were measured. A 10 period superlattice structure with a total thickness of approximately 400 A worked well as an electron barrier. The structure had a current density of about one A/sq cm at one volt at room temperature. The capacitance variation of these structures was small because of the design of the GaAs cladding layers. The second test structure was used to study cladding layer designs. These wafers were InGaAs and InAlAs layers lattice matched to an InP substrate. The layers have n(+) doping spikes near the barrier to increase the zero bias capacitance and control the shape of the capacitance vs. voltage characteristic. These structures have a capacitance ratio of 5:1 and an abrupt change from maximum to minimum capacitance. The measurements were made at 80 K. Based on the information obtained from these two structures, we have designed a structure that combines the low current density barrier with the improved cladding layers. The capacitance and current-voltage characteristics from this structure are presented. Author (revised)

N93-27739*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
A NEW FABRICATION TECHNIQUE FOR BACK-TO-BACK VARACTOR DIODES **c33**
R. Peter Smith, Debabani Choudhury, Suzanne Martin, Margaret A. Frerking, John K. Liu, and Frank A. Grunthaner *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 158-163 Sponsored in part by ARO (For primary document see N93-27726 10-31)
Avail: CASI HC A02/MF A06

A new varactor diode process has been developed in which much of the processing is done from the back of an extremely thin semiconductor wafer laminated to a low-dielectric substrate. Back-to-back BNN diodes were fabricated with this technique; excellent DC and low-frequency capacitance measurements were obtained. Advantages of the new technique relative to other techniques include greatly reduced frontside wafer damage from exposure to process chemicals, improved capability to integrate devices (e.g. for antenna patterns, transmission lines, or wafer-scale grids), and higher line yield. BNN diodes fabricated with this technique exhibit approximately the expected capacitance-voltage characteristics while showing leakage currents under 10 mA at voltages three times that needed to deplete the varactor. This leakage is many orders of magnitude better than comparable Schottky diodes. Author

N93-27740*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
A 200 GHz TRIPLER USING SINGLE BARRIER VARACTOR **c33**
Debabani Choudhury, Margaret A. Frerking, and Paul D. Batelaan *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 164-180 (For primary document see N93-27726 10-31)
Avail: CASI HC A03/MF A06

The GaAs Schottky varactor diode is the nonlinear device most commonly used for submillimeter wave harmonic generation. Output power adequate to serve as a local oscillator source for SIS tunnel junctions has been demonstrated with whisker-contacted GaAs Schottky varactor multipliers in waveguide mounts up to about 800 GHz. In this paper, we present results for a tripler to 200 GHz using a new multiplier device, the single barrier varactor (SBV). This new varactor has a potential advantages such as stronger nonlinearities or special symmetry, which make it attractive for submillimeter wave frequency multiplication. The performance of a tripler using a SBV over a output frequency range from 186 to 207 GHz has been measured in a crossed waveguide mount. The theoretical performance of the device has been calculated using large signal analysis. A comparison of theoretical and measured results and a discussion of various losses in the mount and the varactor have also been presented. Author

N93-27741*# Five-College Astronomy Dept., Amherst, MA.
A SUBMILLIMETER TRIPLER USING A QUASI-WAVEGUIDE STRUCTURE **c33**
Neal R. Erickson and German Cortes-Medellin *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 181-188 (For primary document see N93-27726 10-31)
Avail: CASI HC A02/MF A06

A new type of frequency multiplier structure is being developed which is suitable for application at frequencies above 1 THz. This structure preserves some of the properties of waveguide for mode control, yet is not truly single mode. The device resembles a sectoral horn, with a varactor diode mounted near the throat. Input and output coupling are through the same aperture, requiring a quasi-optical diplexer. Initial tests are directed at building a tripler at 500 GHz, for comparison with waveguide structures. The diplexer is a blazed diffraction grating with appropriate focusing optics. Model studies show that the impedance match to a varactor should be good, and initial tests of the beam patterns of the prototype indicate that optical coupling efficiency should be very high. The structure also has the potential for use as a fundamental mixer, or as a third harmonic mixer. Author

N93-27742*# Observatoire de Paris-Meudon (France).
A 380 GHz SIS RECEIVER USING Nb/AlO(x)/Nb JUNCTIONS FOR A RADIOASTRONOMICAL BALLOON-BORNE EXPERIMENT: PRONAOS **c89**
P. Febvre, P. Feautrier (Ecole Normale Superieure, Paris, France.), C. Robert, J. C. Pernot (Ecole Normale Superieure, Paris, France.), A. Germont, M. Hanus (Ecole Normale Superieure, Paris, France.), R. Maoli, M. Gheudin, G. Beaudin, and P. Encrenaz (Ecole Normale Superieure, Paris, France.) *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 189-209 Sponsored in part by CNES and CNRS (For primary document see N93-27726 10-31)
Avail: CASI HC A03/MF A06

The superheterodyne detection technique used for the spectrometer instrument of the PRONAOS project will provide a very high spectral resolution (delta nu/nu = 10(exp -6)). The most critical components are those located at the front-end of the receiver: their contribution dominates the total noise of the receiver. Therefore, it is important to perform accurate studies for specific components, such as mixers and multipliers working in the submillimeter wave range. Difficulties in generating enough local oscillator (LO) power at high frequencies make SIS mixers very desirable for operation above 300 GHz. The low LO power requirements and the low noise temperature of these mixers are the primary reason for building an SIS receiver. This paper reports the successful fabrication of small (less than or equal to 1 sq micron) Nb/Al-O(x)/Nb junctions and arrays with excellent I-V characteristics and very good reliability, resulting in a low noise receiver performance measured in the 368/380 GHz frequency range. Author (revised)

N93-27743*# Groningen Rijksuniv. (Netherlands).
A LOW NOISE 410-495 HETERODYNE TWO TUNER MIXER, USING SUBMICRON Nb/Al2O3/Nb TUNNELJUNCTIONS **c33**
G. deLange, C. E. Honingh (Space Research Organization Netherlands, Groningen.), M. M. T. M. Dierichs, R. A. Panhuyzen, H. H. A. Schaeffer (Space Research Organization Netherlands, Groningen.), T. M. Klapwijk, H. vandeStadt (Space Research Organization Netherlands, Groningen.), and M. W. M. deGraauw (Space Research Organization Netherlands, Groningen.) *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 210-221 Sponsored in part by Stichting Technische Wetenschappen and Stichting voor Fundamenteel Onderzoek der Materie (For primary document see N93-27726 10-31)
(Contract ESA-7898/88/NL/PB(SC))
Avail: CASI HC A03/MF A06

A 410-495 GHz heterodyne receiver, with an array of two Nb/Al2O3/Nb tunneljunctions as mixing element is described. The noise temperature of this receiver is below 230 K (DSB) over the whole frequency range, and has lowest values of 160 K in the 435-460 GHz range. The calculated DSB mixergain over the whole frequency range varies from -11.9 plus or minus 0.6 dB to -12.6 plus or minus 0.6 dB and the mixer noise is 90 plus or minus 30 K. Author

N93-27744*# Chalmers Univ. of Technology, Goeteborg (Sweden). Dept. of Applied Electron Physics.
DOUBLE DIPOLE ANTENNA SIS RECEIVERS AT 100 AND 400 GHz **c33**
A. Skalare (Space Research Organization Netherlands, Groningen.), H. vandeStadt (Space Research Organization Netherlands, Groningen.), T. deGraauw (Space Research Organization Netherlands, Groningen.), R. A. Panhuyzen (Groningen Rijksuniv., Netherlands.), and M. M. T. M. Dierichs (Groningen Rijksuniv., Netherlands.) *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 222-233 (For primary document see N93-27726 10-31)
(Contract ESA-7898/88/NL/PB(SC))
Avail: CASI HC A03/MF A06

Antenna patterns were measured between 95 and 120 GHz for a double dipole antenna / ellipsoidal lens combination. The structure produces a non-astigmatic beam with low side lobe levels over that whole band. A heterodyne SIS receiver based on this concept gave a best noise temperature of 145 K DSB at 98 GHz. Measurements were also made with a 400 GHz heterodyne SIS receiver, using a double dipole antenna in conjunction with a hyperhemispherical lens. The best noise temperature was 220 K DSB at 402 GHz. On-chip stubs were used to tune out the SIS junction capacitance. Author

N93-27745*# California Inst. of Tech., Pasadena. Physics Lab.
SLOT ANTENNA SIS MIXERS FOR SUBMILLIMETER WAVELENGTHS Abstract Only **c32**
Jonas Zmuidzinas, Henry G. LeDuc (Jet Propulsion Lab., California Inst. of Tech., Pasadena.), and J. A. Stern (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 234 (For primary document see N93-27726 10-31)
Avail: CASI HC A01/MF A06

We are developing improved versions of a slot antenna SIS mixer which we have previously described. The initial work demonstrated a double sideband noise temperature of 420 K for a 500 GHz quasi-optical SIS mixer employing a twin-slot antenna on a quartz dielectric substrate. A quartz hyperhemispherical lens is used to focus the incoming radiation onto the twin-slot antenna. The advantages of a twin-slot antenna include a low impedance (35 omega) and a clean, symmetric beam pattern into the dielectric with a 70 percent efficiency. In our original mixer, the radiation was coupled from the two slot antennas onto superconducting microstrip lines which fed the SIS junction. By performing an impedance transformation using tapered lines and by feeding the radiation from the two slots to the junction in parallel, the effective (real) impedance seen by the junction was reduced to just 4 omega. This very low impedance allowed a junction area of 2.3 sq micron to be used at 500 GHz, which was manufactured using optical lithography. However, no attempt was made to tune out the junction capacitance. We estimate that this capacitance reduces the impedance coupling efficiency to eta(sub Z) approx. equals 0.23, for our junction with omega R(sub N) C = 5.3 at 500 GHz. The recent development of techniques using electron-beam lithography to manufacture junctions with very small areas (approx. equals 0.1 sq microns) now allows considerably more flexibility in the design of SIS mixer circuits. We have redesigned the slot-antenna mixer to take advantage of this possibility. In particular, we have included a novel circuit which allows the junction capacitance to be tune out over a broad bandwidth. For instance, mixers designed for 800 GHz using NbN/MgO/NbN junctions with realistic parameters achieve a 3 dB impedance bandwidth of nearly 400 GHz. Furthermore, our circuit uses only short lengths of microstrip and should be less sensitive to RF losses than other designs. The improved impedance match should give a large reduction in noise temperature as compared to our previous mixer. The new devices are currently under fabrication. Further details of the design and any available experimental results are discussed.
Author

N93-27746*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
A PLANAR QUASI-OPTICAL SIS RECEIVER FOR ARRAY APPLICATIONS **c33**
Philip A. Stimson, Robert J. Dengler, Peter H. Siegel, and Henry G. LeDuc *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 235-242 (For primary document see N93-27726 10-31)
Avail: CASI HC A02/MF A06

A planar, quasi-optical SIS receiver operating at 230 GHz is described. The receiver consists of a 2 x 5 array of half wave dipole antennas with ten niobium-aluminum oxide-niobium SIS junctions on a quartz dielectric-filled parabola. The 1.4 GHz intermediate frequency is coupled from the mixer via coplanar strip transmission lines and 4:1 balun transformers. The receiver is operated at 4.2 K in a liquid helium immersion cryostat. We report accurate measurements of the performance of single receiver elements. A mixer noise temperature of 89 K DSB, receiver noise temperature of 156 K DSB, and conversion loss of 3 dB into a matched load have been obtained.
Author

N93-27747*# California Inst. of Tech., Pasadena. Div. of Physics, Mathematics and Astronomy.
A FIXED TUNED BROADBAND MATCHING STRUCTURE FOR SUBMILLIMETER SIS RECEIVERS Abstract Only **c33**
Thomas H. Buettgenbach, Henry G. LeDuc (Jet Propulsion Lab., California Inst. of Tech., Pasadena.), Paul D. Maker (Jet Propulsion Lab., California Inst. of Tech., Pasadena.), and T. G. Phillips *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 243 (For primary document see N93-27726 10-31)
Avail: CASI HC A01/MF A06

We have designed, fabricated, and tested a quasi-optical spiral antenna mixer with a Nb/AlO(x)/Nb tunnel junction. This design incorporates a hybrid antenna fed by a planar logarithmic spiral antenna to couple to the radiation field, as previously done with Pb based devices, as well as a newly designed matching circuit. This matching circuit is a relatively complex structure requiring several layers of photolithographic processing on top of the actual tunneling device. Computer modeling of the device predicted the measured bandwidth to within 8 percent, making scale model measurements unnecessary. We have obtained a good match from 210 GHz to 460 GHz between the antenna and a relatively large area (1.25 by 1.25 sq microns) tunnel junction with omega R(sub N) C approx. = 2 - 4.4. This compares to simple inductive stubs that attain only a few percent of total bandwidth in the submillimeter band or inductively tuned SIS arrays with an upper limit of operating frequencies well below the submillimeter band. Noise temperatures were measured at 345 GHz, 426 GHz, and 492 GHz yielding double sideband noise temperatures at 200 K, 220 K, and 500 K, respectively.
Author

N93-27748*# Institut de Radio Astronomie Millimetrique, Saint Martin d'Heres (France).
MODELLING AND PERFORMANCE OF Nb SIS MIXERS IN THE 1.3 mm AND 0.8 mm BANDS **c33**
A. Karpov, M. Carter, B. Lazareff, D. Billon-Pierron, and K. H. Gundlach *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 244-250 (For primary document see N93-27726 10-31)
Avail: CASI HC A02/MF A06

We describe the modeling and subsequent improvements of SIS waveguide mixers for the 200-270 and 330-370 GHz bands (Blundell, Carter, and Gundlach 1988, Carter et al 1991). These mixers are constructed for use in receivers on IRAM radiotelescopes on Pico Veleta (Spain, Sierra Nevada) and Plateau de Bure (French Alps), and must meet specific requirements. The standard reduced height waveguide structure with suspended stripline is first analyzed and a model is validated through comparison with scale model and working scale measurements. In the first step, the intrinsic limitations of the standard mixer structure are identified, and the parameters are optimized bearing in mind the radioastronomical applications. In the second step, inductive tuning of the junctions is introduced and optimized for minimum noise and maximum bandwidth. In the 1.3 mm band, a DSB receiver temperature of less than 110 K (minimum 80 K) is measured from 180 through 260 GHz. In the 0.8 mm band, a DSB receiver temperature of less than 250 K (minimum 175 K) is obtained between 325 and 355 GHz. All these results are obtained with room-temperature optics and a 4 GHz IF chain having a 500 MHz bandwidth and a noise temperature of 14 K.
Author

N93-27749*# Space Research Organization Netherlands, Groningen.
COMPARISON OF MEASURED AND PREDICTED PERFORMANCE OF A SIS WAVEGUIDE MIXER AT 345 GHz **c33**
C. E. Honingh, G. deLange (Groningen Rijksuniv., Netherlands.), M. M. T. M. Dierichs (Groningen Rijksuniv., Netherlands.), H. H. A. Schaeffer, J. Wezelman, J. vandeKuur (Groningen Rijksuniv., Netherlands.), T. deGraauw, and T. M. Klapwijk (Groningen Rijksuniv., Netherlands.) *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 251-265 (For primary document see N93-27726 10-31)
(Contract ESA-7898/88/NL/PB(SC))
Avail: CASI HC A03/MF A06

The measured gain and noise of a SIS waveguide mixer at 345 GHz have been compared with theoretical values, calculated from the quantum mixer theory using a three port model. As a mixing element, we use a series array of two Nb-Al2O3-Nb SIS junctions. The area of each junction is 0.8 sq microns and the normal state resistance is 52 omega. The embedding impedance of the mixer has been determined from the pumped DC-IV curves of the junction and is compared to results from scale model measurements (105 x). Good agreement was obtained. The measured mixer gain, however, is a factor of 0.45 plus or minus 0.5 lower than the theoretical predicted gain. The measured mixer noise temperature is a factor of 4-5 higher than the calculated one. These discrepancies are independent on pump power and are valid for a broad range of tuning conditions.
Author

N93-27750*# California Inst. of Tech., Pasadena.
A LOW-NOISE 492 GHz SIS WAVEGUIDE RECEIVER **c33**
C. K. Walker, J. W. Kooi, M. Chan, Henry G. LeDuc (Jet Propulsion Lab., California Inst. of Tech., Pasadena.), P. L. Schaffer, J. E. Carlstrom, and T. G. Phillips *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 266-279 (For primary document see N93-27726 10-31)
(Grant NSF AST-90-15755)
Avail: CASI HC A03/MF A06

We discuss the design and performance of an SIS waveguide receiver which provides low noise performance from 375 to 510 GHz. At its design frequency of 492 GHz, the receiver has a double sideband noise temperature of approx. 172 K. By using embedded magnetic field concentrators, we are able to effectively suppress Josephson pair tunneling. Techniques for improving receiver performance are discussed. Author (revised)

N93-27751*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
SLOT-LINE END-FIRE ANTENNAS FOR THz FREQUENCIES **c32**
H. Ekstroem (Chalmers Univ. of Technology, Goeteborg, Sweden.), S. Gearhart (Michigan Univ., Ann Arbor.), P. R. Acharya (Chalmers Univ. of Technology, Goeteborg, Sweden.), H. Dave, G. Rebeiz (Michigan Univ., Ann Arbor.), S. Jacobsson (Chalmers Univ. of Technology, Goeteborg, Sweden.), E. Kollberg (Chalmers Univ. of Technology, Goeteborg, Sweden.), and G. Chin *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 280-290 (For primary document see N93-27726 10-31)
Avail: CASI HC A03/MF A06

Tapered slot-line endfire antennas, of BLTSA type, have been fabricated on 1.7 micron thin SiO2/Si3N4 (epsilon (sub r) = 4.5) dielectric membranes. The antenna patterns, in the E-, H-, D- and D-cross planes, were measured at 270, 348, 370, and 802 GHz using bismuth micro bolometer detectors. The antennas have approximately 12 dB directivity, and the -10 dB beam widths are 50 and 55 degrees in the E- and H-planes at 348 GHz, respectively. The measurements at millimeter/submillimeter wavelengths compare well with scale measurements at 45 GHz as well as with theoretical predictions. The overall results are encouraging and show that slot-line antennas can be fabricated for use at THz frequencies. Furthermore, it is shown that the very thin SiO2/Si3N4 membranes are strong enough to be used in practical applications. Author

N93-27752*# Clemson Univ., SC. Dept. of Electrical and Computer Engineering.
QUASI-OPTICAL ANTENNA-MIXER-ARRAY DESIGN FOR TERAHERTZ FREQUENCIES **c33**
Yong Guo, Kent A. Potter (California Inst. of Tech., Pasadena.), and David B. Rutledge (California Inst. of Tech., Pasadena.) *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 291-297 Sponsored in part by Aerojet Electrosystems Co. and ARO (For primary document see N93-27726 10-31)
Avail: CASI HC A02/MF A06

A new quasi-optical antenna-mixer-array design for terahertz frequencies is presented. In the design, antenna and mixer are combined into an entity, based on the technology in which millimeter-wave horn antenna arrays have been fabricated in silicon wafers. It consists of a set of forward- and backward-looking horns made with a set of silicon wafers. The front side is used to receive incoming signal, and the back side is used to feed local oscillator signal. Intermediate frequency is led out from the side of the array. Signal received by the horn array is picked up by antenna probes suspended on thin silicon-oxynitride membranes inside the horns. Mixer diodes will be located on the membranes inside the horns. Modeling of such an antenna-mixer-array design is done on a scaled model at microwave frequencies. The impedance matching, RF and LO isolation, and patterns of the array have been tested and analyzed.
Author

N93-27753*# Michigan Univ., Ann Arbor. NASA Center for Space Terahertz Technology.
ANALYSIS OF A NOVEL NON-CONTACTING WAVEGUIDE BACKSHORT **c32**
T. M. Weller, L. P. B. Katehi, and William R. McGrath (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) *In its* The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 298-315 (For primary document see N93-27726 10-31)
Avail: CASI HC A03/MF A06

A new non-contacting waveguide backshort has been developed for millimeter and submillimeter wave frequencies. The design consists of a metal bar with rectangular or circular holes cut into it, which is covered with a dielectric (mylar) layer to form a snug fit with the walls of a waveguide. Hole geometries are adjusted to obtain a periodic variation of the guide impedance on the correct length scale, in order to produce efficient reflection of RF power. It is a mechanically rugged design which can be easily fabricated for frequencies from 1 to 1000 GHz and is thus a sound alternative to the miniaturization of conventional non-contacting shorts. To aid in high-frequency design, a rigorous full-wave analysis has been completed, which will allow variations of the size, number and spacing of the holes to be easily analyzed. This paper will review the backshort design and the method developed for theoretical characterization, followed by a comparison of the experimental and numerical results. Low frequency models operating from 4-6 GHz are shown to demonstrate return loss of greater than -0.2 dB over a 33 percent bandwidth. The theory is in good agreement with measured data. Author

N93-27754*# California Inst. of Tech., Pasadena. Dept. of Electrical Engineering.
SILICON MICROMACHINED WAVEGUIDES FOR MILLIMETER AND SUBMILLIMETER WAVELENGTHS **c32**
Markus Yap, Yu-Chong Tai, William R. McGrath (Jet Propulsion Lab., California Inst. of Tech., Pasadena.), and Christopher Walker (Arizona Univ., Tucson.) *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 316-323 Sponsored in part by Strategic Defense Initiative Organization (For primary document see N93-27726 10-31)
(Contract PF-347)
Avail: CASI HC A02/MF A06

The majority of radio receivers, transmitters, and components operating at millimeter and submillimeter wavelengths utilize rectangular waveguides in some form. However, conventional machining techniques for waveguides operating above a few hundred GHz are complicated and costly. This paper reports on the development of silicon micromachining techniques to create silicon-based waveguide circuits which can operate at millimeter and submillimeter wavelengths. As a first step, rectangular WR-10 waveguide structures have been fabricated from (110) silicon wafers using micromachining techniques. The waveguide is split along the broad wall. Each half is formed by first etching a channel completely through a wafer. Potassium hydroxide is used to etch smooth mirror-like vertical walls and LPCVD silicon nitride is used as a masking layer. This wafer is then bonded to another flat wafer using a polyimide bonding technique and diced into the U-shaped half wavelengths. Finally, a gold layer is applied to the waveguide walls. Insertion loss measurements show losses comparable to those of standard metal waveguides. It is suggested that active devices and planar circuits can be integrated with the waveguides, solving the traditional mounting problems. Potential applications in terahertz instrumentation technology are further discussed. Author

N93-27755*# Michigan Univ., Ann Arbor. NASA Center for Space Terahertz Technology.
PROGRESS IN INTEGRATED-CIRCUIT HORN ANTENNAS FOR RECEIVER APPLICATIONS. PART 1: ANTENNA DESIGN **c32**
George V. Eleftheriades, Walid Y. Ali-Ahmad, and Gabriel M. Rebeiz *In its* The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 324-337 Submitted for publication (For primary document see N93-27726 10-31)
Avail: CASI HC A03/MF A06

The purpose of this work is to present a systematic method for the design of multimode quasi-integrated horn antennas. The design methodology is based on the Gaussian beam approach and the structures are optimized for achieving maximum fundamental Gaussian coupling efficiency. For this purpose, a hybrid technique is employed in which the integrated part of the antennas is treated using full-wave analysis, whereas the machined part is treated using an approximate method. This results in a simple and efficient design process. The developed design procedure has been applied for the design of a 20, a 23, and a 25 dB quasi-integrated

horn antennas, all with a Gaussian coupling efficiency exceeding 97 percent. The designed antennas have been tested and characterized using both full-wave analysis and 90 GHz/370 GHz measurements. Author

N93-27756*# Michigan Univ., Ann Arbor. NASA Center for Space Terahertz Technology.
PROGRESS IN INTEGRATED-CIRCUIT HORN ANTENNAS FOR RECEIVER APPLICATIONS. PART 2: A 90 GHz QUASI-INTEGRATED HORN ANTENNA RECEIVER **c32**
Walid Y. Ali-Ahmad, George V. Eleftheriades, and Gabriel M. Rebeiz *In its* The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 338-344 (For primary document see N93-27726 10-31)
Avail: CASI HC A02/MF A06

A receiver belonging to the family of integrated planar receivers has been developed at 90 GHz. It consists of a planar Schottky-diode placed at the feed of a dipole-probe suspended inside an integrated horn antenna. The measured planar mixer single-sideband conversion loss at 91.2 GHz (LO) with a 200 MHz IF frequency is 8.3dB plus or minus 0.3dB. The low cost of fabrication and simplicity of this design makes it ideal for millimeter and submillimeter-wave receivers. Author (revised)

N93-27757*# Five-College Astronomy Dept., Amherst, MA.
ZONE PLATE LENS ANTENNAS FOR MILLIMETER AND SUBMILLIMETER WAVELENGTHS **c32**
Paul F. Goldsmith *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 345-361 Prepared in cooperation with Millitech Corp., South Deerfield, MA (For primary document see N93-27726 10-31)
Avail: CASI HC A03/MF A06

Zone plate lenses are a type of focusing element which function essentially as differential phase shifters, having a relatively few, coarsely quantized phase delays across the incident beam of radiation. The major advantages are ease of fabrication and much reduced thickness, compared to conventional refractive focusing elements. These considerations are both of particular importance for the submillimeter range, in which manufacturing tolerances for curved optical elements can pose significant problems, and where the absorption of readily available dielectric materials is quite large. In this presentation we briefly review the theory of zone plate lens operations, present a relatively simple method for calculating the aperture efficiency of zone plate lenses used as antennas, and show some theoretical and measured results in the 100 GHz range. Author

N93-27758*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
ONSET OF DISPERSION IN Nb MICROSTRIP TRANSMISSION LINES AT SUBMILLIMETER WAVE FREQUENCIES **c33**
H. H. S. Javadi, William R. McGrath, B. Bumble, and Henry G. LeDuc *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 362-381 Sponsored in part by Strategic Defense Initiative Organization (For primary document see N93-27726 10-31)
Avail: CASI HC A03/MF A06

We have measured the dispersion in phase velocity of a Nb-SiO(x)-Nb microstrip transmission line resonator over a frequency range from 50 GHz to 800 GHz. A submicron Nb/Al-AlO(x)/Nb Josephson junction was used as a voltage-controlled oscillator to excite the high order modes in the resonator. The same junction is used as a direct detector resulting in a series of step-like structures in the DC current-voltage characteristic at the position of each mode frequency. The transmission line is dispersionless up to about 500 GHz where the phase velocity begins to decrease. This is well below the gap frequency f(sub g) approx. equals 700 GHz. Results agree qualitatively with the expected theoretical behavior near f(sub g). This onset of dispersion and loss in Nb transmission lines will have a significant impact on the design of submillimeter wave RF circuits. Author

N93-27759*# Michigan Univ., Ann Arbor. NASA Center for Space Terahertz Technology.
DOUBLE-SLOT ANTENNAS ON EXTENDED HEMISPHERICAL DIELECTRIC LENSES **c32**
Daniel F. Filipovic, Steve J. Gearhart, Brian K. Kormanyos, and Gabriel M. Rebeiz *In its* The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 382-393 (For primary document see N93-27726 10-31)
Avail: CASI HC A03/MF A06

An investigation of the coupling efficiencies to a gaussian-beam of a double-slot antenna on a hyperhemispherical lens is presented. It is shown that both lenses couple equally well to an appropriate gaussian beam (about 80 percent). The radiation patterns of both lenses with a double-slot antenna are computed using the ray-tracing method. The experimental radiation patterns are presented and show close agreement to the theoretically computed patterns. Author

N93-27760*# National Radio Astronomy Observatory, Charlottesville, VA.
EMBEDDING IMPEDANCE APPROXIMATIONS IN THE ANALYSIS OF SIS MIXERS **c33**
A. R. Kerr, S.-K. Pan, and S. Withington (Cambridge Univ., England.) *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 394-407 Sponsored in part by NSF (For primary document see N93-27726 10-31)
Avail: CASI HC A03/MF A06

Future millimeter-wave radio astronomy instruments will use arrays of many SIS receivers, either as focal plane arrays on individual radio telescopes, or as individual receivers on the many antennas of radio interferometers. Such applications will require broadband integrated mixers without mechanical tuners. To produce such mixers, it will be necessary to improve present mixer design techniques, most of which use the three-frequency approximation to Tucker's quantum mixer theory. This paper examines the adequacy of three approximations to Tucker's theory: (1) the usual three-frequency approximation which assumes a sinusoidal LO voltage at the junction, and a short-circuit at all frequencies above the upper sideband; (2) a five-frequency approximation which allows two LO voltage harmonics and five small-signal sidebands; and (3) a quasi five-frequency approximation in which five small-signal sidebands are allowed, but the LO voltage is assumed sinusoidal. These are compared with a full harmonic-Newton solution of Tucker's equations, including eight LO harmonics and their corresponding sidebands, for realistic SIS mixer circuits. It is shown that the accuracy of the three approximations depends strongly on the value of omega R(sub N)C for the SIS junctions used. For large omega R(sub N)C, all three approximations approach the eight-harmonic solution. For omega R(sub N)C values in the range 0.5 to 10, the range of most practical interest, the quasi five-frequency approximation is a considerable improvement over the three-frequency approximation, and should be suitable for much design work. For the realistic SIS mixers considered here, the five-frequency approximation gives results very close to those of the eight-harmonic solution. Use of these approximations, where appropriate, considerably reduces the computational effort needed to analyze an SIS mixer, and allows the design and optimization of mixers using a personal computer. Author

N93-27761*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
SUB MICRON AREA Nb/AlO(x)/Nb TUNNEL JUNCTIONS FOR SUBMILLIMETER MIXER APPLICATIONS **c33**
Henry G. LeDuc, B. Bumble, S. R. Cypher, A. J. Judas, and J. A. Stern *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 408-418 Sponsored in part by Strategic Defense Initiative Organization (For primary document see N93-27726 10-31)
Avail: CASI HC A03/MF A06

In this paper, we report on a fabrication process developed for submicron area tunnel junctions. We have fabricated Nb/AlO(x)/Nb tunnel junctions with areas down to 0.1 sq micron using these techniques. The devices have shown excellent performance in receiver systems up to 500 GHz and are currently in use in radio astronomy observatories at 115, 230, and 500 GHz. Author (revised)

N93-27762*# California Inst. of Tech., Pasadena.
NOISE IN JOSEPSON EFFECT MIXERS AND THE RSJ MODEL
Abstract Only **c33**
R. Schoelkopf, T. Phillips, and J. Zmuidzinas *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 419 (For primary document see N93-27726 10-31)
Avail: CASI HC A01/MF A06

Josephson effect mixers have previously been observed to display 'excess' noise both in experiments with point contacts and in numerical simulations using the resistively shunted junction (RSJ) model. This excess noise causes the mixer noise temperature to be a factor of typically 20-100 times the physical temperature of the device. Previously, this excess was ascribed to conversion from unwanted sidebands of the local oscillator and Josephson frequencies and their harmonics. Our numerical modeling of the RSJ equations has led to a new understanding of the excess noise, which is simply due to the intrinsic Josephson oscillations of the device. In addition, we have extended the modeling to include the previously ignored case of finite device capacitance (i.e. RSJ capacitance parameter beta(sub c) does not equal 0, which is more realistic for lithographically defined Josephson such as shunted tunnel junctions or SNS bridges. For some cases, this yields an improvement of a factor of two in noise temperature from the zero capacitance models. We will discuss the device parameters which optimize the mixer performance for frequencies approaching the characteristic frequency of the device, which is given by the Josephson frequency at the I(sub c)R(sub n) voltage (nu = 2eI(sub c)R(sub n)/h). These modeling results predict good conversion efficiency and a noise temperature within a factor of a few of the physical temperature. Experiments are in progress to determine the accuracy of this modeling using a waveguide mixer at 100 GHz with optimized, resistively shunted Nb tunnel junctions. If the modeling results are valid, they are particularly encouraging for mixers in the submillimeter regime, given the possibility of obtaining non-hysteretic Josephson devices with I(sub c)R(sub n) products in excess of a millivolt, using for instance, high-T(sub c) SNS bridges. We discuss the modifications to the classical RSJ model which are necessary in the quantum regime (h nu greater than kT), and conclude the Josephson mixers may attain noise temperatures less than ten times the quantum limit at high frequencies. Author (revised)

N93-27763*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
FABRICATION AND CHARACTERIZATION OF HIGH CURRENT-DENSITY, SUBMICRON, NbN/MgO/NbN TUNNEL JUNCTIONS **c76**
J. A. Stern, Henry G. LeDuc, and A. J. Judas *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 420-438 Sponsored in part by Strategic Defense Initiative Organization (For primary document see N93-27726 10-31)
Avail: CASI HC A03/MF A06

At near-millimeter wavelengths, heterodyne receivers based on SIS tunnel junctions are the most sensitive available. However, in order to scale these results to submillimeter wavelengths, certain device properties should be scaled. The tunnel-junction's current density should be increased to reduce the RC product. The device's area should be reduced to efficiently couple power from the antenna to the mixer. Finally, the superconductor used should have a large energy gap to minimize RF losses. Most SIS mixers use Nb or Pb-alloy tunnel junctions; the gap frequency for these materials is approximately 725 GHz. Above the gap frequency, these materials exhibit losses similar to those in a normal metal. The gap frequency in NbN films is as-large-as 1440 GHz. Therefore, we have developed a process to fabricate small area (down to 0.13 sq microns), high current density, NbN/MgO/NbN tunnel junctions. Author (revised)

N93-27764*# Massachusetts Inst. of Tech., Lexington. Lincoln Lab.
A QUASIOPTICAL RESONANT-TUNNELING-DIODE OSCILLATOR OPERATING ABOVE 200 GHz Abstract Only **c33**
E. R. Brown, C. D. Parker, K. M. Molvar, A. R. Calawa, and M. J. Manfra *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 439 Sponsored in part by ARO (For primary document see N93-27726 10-31)
Avail: CASI HC A01/MF A06

We have fabricated and characterized a quasioptically stabilized resonant-tunneling-diode (RTD) oscillator having attractive performance characteristics for application as a radiometric local oscillator. The fundamental frequency of the oscillator is tunable from about 200 to 215 GHz, the instantaneous linewidth is between 10 and 20 kHz, and the output power across the tuning band is about 50 micro-W. The narrow linewidth and fine tuning of the frequency are made possible by a scanning semiconfocal open cavity which acts as the high-Q resonator for the oscillator. The cavity is compact, portable, and insensitive to vibration and temperature variation. The total dc power consumption (RTD plus bias supply) is only 10 mW. The present oscillator provides the highest power obtained to date from an RTD above 200 GHz. We attribute this partly to the use of the quasioptical resonator, but primarily to the quality of the RTD. It is fabricated from the In(0.53)Ga(0.47)As/AlAs materials system, which historically has yielded the best overall resonant-tunneling characteristics of any material system. The RTD active area is 4 sq microns, and the room-temperature peak current density and peak-to-valley current ratio are 2.5x10(exp 5) A cm(exp -2) and 9, respectively. The RTD is mounted in a WR-3 standard-height rectangular waveguide and is contacted across the waveguide by a fine wire that protrudes through a via hole in a Si3N4 'honeycomb' overlayer. We estimate that the theoretical maximum frequency of oscillation of this RTD is approximately 1.1 THz, and that scaled-down versions of the same quasioptical oscillator design should operate in a fundamental mode up to frequencies of at least 500 GHz. Author (revised)

N93-27765*# Michigan Univ., Ann Arbor. NASA Center for Space Terahertz Technology.
TRANSIT-TIME DEVICES AS LOCAL OSCILLATORS FOR FREQUENCIES ABOVE 100 GHz **c33**
H. Eisele, C. Kidner, and G. I. Haddad *In its* The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 440-456 (For primary document see N93-27726 10-31)
Avail: CASI HC A03/MF A06

Very promising preliminary experimental results have been obtained from GaAs IMPATT diodes at F-band frequencies (75 mW, 3.5 percent at 111.1 GHz and 20 mW, 1.4 percent at 120.6 GHz) and from GaAs TUNNETT diodes at W-band frequencies (26 mW, 1.6 percent at 87.2 GHz and 32 mW, 2.6 percent at 93.5 GHz). These results indicate that IMPATT, MITATT and TUNNETT diodes have the highest potential of delivering significant amounts of power at Terahertz frequencies. As shown recently, the noise performance of GaAs W-band IMPATT diodes can compete with that of Gunn devices. Since TUNNETT diodes take advantage of the quieter tunnel injection, they are expected to be especially suited for low-noise local oscillators. This paper will focus on the two different design principles for IMPATT and TUNNETT diodes, the material parameters involved in the design and some aspects of the present device technology. Single-drift flat-profile GaAs D-band IMPATT diodes had oscillations up to 129 GHz with 9 mW, 0.9 percent at 128.4 GHz. Single-drift GaAs TUNNETT diodes had oscillations up to 112.5 GHz with 16 mW and output power levels up to 33 mW and efficiencies up to 3.4 percent around 102 GHz. These results are the best reported so far from GaAs IMPATT and TUNNETT diodes. Author

N93-27766*# Utah Univ., Salt Lake City. Dept. of Electrical Engineering.
NEGATIVE DIFFERENTIAL RESISTANCE (NDR) FREQUENCY CONVERSION WITH GAIN **c33**
R. J. Hwu, R. W. Alm, and S. C. Lee *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 457-476 (For primary document see N93-27726 10-31)
Avail: CASI HC A03/MF A06

The dependence of the I-V characteristic of the negative differential resistance (NDR) devices on the power level and frequency of the rf input signal has been theoretically analyzed with a modified large- and small-signal nonlinear circuit analysis program. The NDR devices we used in this work include both the tunnel diode (without the antisymmetry in the I-V characteristic) and resonant-tunneling devices (with the antisymmetry in the I-V characteristic). Absolute negative conductance can be found from a zero-biased resonant tunneling device when the applied pump power is within a small range. This study verifies the work of Sollner et al. Variable negative conductances at the fundamental and harmonic frequencies can also be obtained from both the unbiased and biased tunnel diodes. The magnitude of the negative conductances can be adjusted by varying the pump amplitude -- a very useful circuit property. However, the voltage range over which the negative conductance occurs moves towards the more positive side of the voltage axis with increasing frequency. Furthermore, the range of the pumping amplitude to obtain negative conductance varies with the parasitics (resistance and capacitance) of the device. The theoretical observation of the dependence of the I-V characteristic of the NDR devices on the power and frequency of the applied pump signal is supported by

the experimental results. In addition, novel functions of a NDR device such as self-oscillating frequency multiplier and mixer with gain have been experimentally demonstrated. The unbiased oscillator have also been successfully realized with a NDR device with an antisymmetrical I-V characteristic. Finally, the applications of these device functions will be discussed. Author (revised)

N93-27767*# Michigan Univ., Ann Arbor. Solid-State Electronics Lab.
MODELING, DESIGN, FABRICATION, AND TESTING OF InP GUNN DEVICES IN THE D-BAND (110 GHz - 170 GHz) **c33**
R. Kamoua, H. Eisele, J. R. East, G. I. Haddad, G. Munns, and M. Sherwin *In its* The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 477-493 (For primary document see N93-27726 10-31)
Avail: CASI HC A03/MF A06

The development of fundamental Gunn sources for D-band frequencies requires improvements of doping profiles, processing technology, and circuit design. We have developed a technology for fabricating InP Gunn diodes using an InGaAs etch-stop layer between the InP substrate and the device layers. The epitaxial layers were grown by CBE. During device processing, the substrate is completely removed. Substrateless devices with an n(+) InGaAs cap layer are expected to have reduced contact and series resistances, and skin effect losses. This technology gives better uniformity and control of the device geometry across the processed chip. InP Gunn devices with a 1.7 micron long active region (doping : 9 x 10(exp 15) cm(exp -3)) have been mounted on copper heat sinks. Two tapered leads were then bonded to the diode and to four quartz standoffs. As a preliminary result, an output power of 13 mW at 82 GHz was obtained. Based on these RF measurements, we determine appropriate material parameters to be used in the Ensemble Monte Carlo model. Subsequently, we use this model to design and evaluate the performance of InP Gunn Devices for D-band frequencies. Using the same technology, we are currently processing Gunn devices with a 1 micron long active region for operation at higher frequencies. Author (revised)

N93-27768*# Cambridge Univ. (England). Cavendish Lab.
RECENT ADVANCES IN SUPERCONDUCTING-MIXER SIMULATIONS **c33**
S. Withington and P. R. Kennedy *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 494-501 (For primary document see N93-27726 10-31)
Avail: CASI HC A02/MF A06

Over the last few years, considerable progress have been made in the development of techniques for fabricating high-quality superconducting circuits, and this success, together with major advances in the theoretical understanding of quantum detection and mixing at millimeter and submillimeter wavelengths, has made the development of CAD techniques for superconducting nonlinear circuits an important new enterprise. For example, arrays of quasioptical mixers are now being manufactured, where the antennas, matching networks, filters and superconducting tunnel junctions are all fabricated by depositing niobium and a variety of oxides on a single quartz substrate. There are no adjustable tuning elements on these integrated circuits, and therefore, one must be able to predict their electrical behavior precisely. This requirement, together with a general interest in the generic behavior of devices such as direct detectors and harmonic mixers, has lead us to develop a range of CAD tools for simulating the large-signal, small-signal, and noise behavior of superconducting tunnel junction circuits. Author (revised)

N93-27769*# Rochester Univ., NY.
SUBMILLIMETER WAVE DETECTION WITH SUPERCONDUCTING TUNNEL DIODES **c33**
Michael J. Wengler *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 502-521 (For primary document see N93-27726 10-31)
(Grant NSF ECS-88-57868)
Avail: CASI HC A03/MF A06

Superconductor-Insulator-Superconductor (SIS) diodes are the detector elements in the most sensitive heterodyne receivers available from 100 to 500 GHz. SIS mixers are the front end of radio astronomical systems around the world. SIS mixer technology is being extended to 1 THz and higher frequencies for eventual use on spaceborne astronomical experiments. Here is a short review of submillimeter SIS mixers. The role of impedance matching in the proper design of an SIS mixer is described. A variety of methods for achieving good impedance match at submillimeter frequencies are presented. The experimental state of the submillimeter SIS mixer art is described and summarized. Author

N93-27770*# Groningen Rijksuniv. (Netherlands). Dept. of Applied Physics.
EVALUATION OF INTEGRATED TUNING ELEMENTS WITH SIS DEVICES **c33**
M. M. T. M. Dierichs, C. E. Honingh (Space Research Organization Netherlands, Groningen.), R. A. Panhuyzen (Space Research Organization Netherlands, Groningen.), B. J. Feenstra, A. Skalare (Space Research Organization Netherlands, Groningen.), J. J. Wijnbergen (Space Research Organization Netherlands, Groningen.), H. vanderStadt (Space Research Organization Netherlands, Groningen.), and T. deGraauw (Space Research Organization Netherlands, Groningen.) *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 522-537 Sponsored in part by Stichting Technische Wetenschappen and Stichting voor Fundamenteel Onderzoek der Materie (For primary document see N93-27726 10-31)
(Contract ESA-7898/88/NL/PB(SC))
Avail: CASI HC A03/MF A06

The resonance of integrated tuning stubs in combination with SIS detectors is measured and modeled. The predicted resonances are compared with measurements of stubs integrated with Nb/Al2O3/Nb junctions in a log-periodic antenna using a Michelson interferometer. Different stub lengths were made on different substrates (on 200 micron thick quartz and on a 7 micron thick silicon membrane) and the results show a fairly good agreement with the model calculations. Quartz substrates showed resonances up to 580 GHz, silicon membrane stub resonances reach as high as 480 GHz. An observed resonance at 560 GHz is probably a substrate effect from the membrane. The gap frequency for all the samples is 650 GHz and no resonances are detected above this frequency. Up to the maximum detected frequency dispersion is found to be negligible. Author (revised)

N93-27771*# Rochester Univ., NY. Dept. of Physics.
SOURCE CONDUCTANCE SCALING FOR HIGH FREQUENCY SUPERCONDUCTING QUASIPARTICLE RECEIVERS **c33**
Qing Ke and M. J. Feldman *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 538-547 Sponsored in part by AFOSR and NSF (For primary document see N93-27726 10-31)
Avail: CASI HC A02/MF A06

It has been suggested that the optimum source conductance G(sub s) for the superconductor-insulator-superconductor (SIS) quasiparticle mixer should have a I/f dependence. This would imply that the critical current density of SIS junctions used for mixing should increase as frequency squared, a stringent constraint on the design of submillimeter SIS mixers, rather than in simple proportion to frequency as previously believed. We have used Tucker's quantum theory of mixing for extensive numerical calculations to determine G(sub s) for an optimized SIS receiver. We find that G(sub s) is very roughly independent of frequency (except for the best junctions at low frequency), and discuss the implications of our results for the design of submillimeter SIS mixers. Author (revised)

N93-27772*# Lille-1 Univ., Villeneuve-d'Asoq (France). Centre Hyperfrequences et Semiconducteurs.
RESONANT TUNNELING DIODES AS SOURCES FOR MILLIMETER AND SUBMILLIMETER WAVELENGTHS **c33**
O. Vanbesien, R. Bouregba, P. Mounaix, D. Lippens, L. Palmateer, J. C. Pernot, G. Beaudin (Observatoire de Paris-Meudon, France.), P. Encrenaz, E. Bockenhoff (Thomson-CSF, Orsay, France.), and J. Nagle (Thomson-CSF, Orsay, France.) et al *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 548-559 Sponsored in part by Ministere de la Recherche et de la Technologie (For primary document see N93-27726 10-31)
Avail: CASI HC A03/MF A06

High-quality Resonant Tunneling Diodes have been fabricated and tested as sources for millimeter and submillimeter wavelengths. The devices have shown excellent I-V characteristics with peak-to-valley current ratios as high as 6:1 and current densities in the range of 50-150 kA/cm(exp 2) at

300 K. Used as local oscillators, the diodes are capable of state of the art output power delivered by AlGaAs-based tunneling devices. As harmonic multipliers, a frequency of 320 GHz has been achieved by quintupling the fundamental oscillation of a klystron source. Author

N93-27773*# Texas Univ., Austin. Dept. of Electrical and Computer Engineering.

SIMULATION OF ELECTRON TRANSPORT IN QUANTUM WELL DEVICES **c33**

D. R. Miller, K. K. Gullapalli, V. R. Reddy, and D. P. Neikirk *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 560-574 Sponsored in part by Texas Advance Research Program (For primary document see N93-27726 10-31)

Avail: CASI HC A03/MF A06

Double barrier resonant tunneling diodes (DBRTD) have received much attention as possible terahertz devices. Despite impressive experimental results, the specifics of the device physics (i.e., how the electrons propagate through the structure) are only qualitatively understood. Therefore, better transport models are warranted if this technology is to mature. In this paper, the Lattice Wigner function is used to explain the important transport issues associated with DBRTD device behavior. Derived from text

N93-27774*# Rochester Univ., NY. Dept. of Electrical Engineering.

PARALLEL ARRAYS OF JOSEPHSON JUNCTIONS FOR SUBMILLIMETER LOCAL OSCILLATORS **c33**

Aleksandar Pance and Michael J. Wengler *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 575-594 (For primary document see N93-27726 10-31)

(Grant AF-AFOSR-0233-90)

Avail: CASI HC A03/MF A06

In this paper we discuss the influence of the DC biasing circuit on operation of parallel biased quasioptical Josephson junction oscillator arrays. Because of nonuniform distribution of the DC biasing current along the length of the bias lines, there is a nonuniform distribution of magnetic flux in superconducting loops connecting every two junctions of the array. These DC self-field effects determine the state of the array. We present analysis and time-domain numerical simulations of these states for four biasing configurations. We find conditions for the in-phase states with maximum power output. We compare arrays with small and large inductances and determine the low inductance limit for nearly-in-phase array operation. We show how arrays can be steered in H-plane using the externally applied DC magnetic field. Author

N93-27775*# California Univ., Los Angeles. Center for High Frequency Electronics.

MONOLITHIC MILLIMETER-WAVE DIODE GRID FREQUENCY MULTIPLIER ARRAYS **c33**

Hong-Xia L. Liu, X.-H. Qin, L. B. Sjogren, W. Wu, E. Chung, C. W. Domier, and N. C. Luhmann, Jr. *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 595-599 Sponsored in part by ARO and DOE (For primary document see N93-27726 10-31)

Avail: CASI HC A01/MF A06

Monolithic diode frequency multiplier arrays, including barrier-N-N(+) (BNN) doubler, multi-quantum-barrier-varactor (MQBV) tripler, Schottky-quantum-barrier-varactor (SQBV) tripler, and resonant-tunneling-diode (RTD) tripler arrays, have been successfully fabricated with yields between 85 and 99 percent. Frequency doubling and/or tripling have been observed for all the arrays. Output powers of 2.4-2.6 W (eta = 10-18 percent) at 66 GHz with the BNN doubler and 3.8-10 W (eta = 1.7-4 percent) at 99 GHz with the SQBV tripler have been achieved. Author (revised)

N93-27776*# Virginia Univ., Charlottesville. Semiconductor Device Lab.

PLANAR GaAs DIODES FOR THz FREQUENCY MIXING APPLICATIONS **c33**

William L. Bishop, Thomas W. Crowe, Robert J. Mattauch, and Hasan Dossal *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 600-615 Sponsored in part by ARO and JPL (For primary document see N93-27726 10-31)

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Avail: CASI HC A03/MF A06

Schottky barrier diodes for terahertz applications are typically fabricated as a micron to sub-micron circular anode metallization on GaAs which is contacted with a sharp wire (whisker). This structure has the benefits of the simplicity of the fabrication of the diode chip, the minimal shunt capacitance of the whisker contact and the ability of the whisker wire to couple energy to the diode. However, whisker-contacted diodes are costly to assembly and difficult to qualify for space applications. Also, complex receiver systems which require many diodes are difficult to assemble. The objective of this paper is to discuss the advantages of planar Schottky diodes for high frequency receiver applications and to summarize the problems of advancing the planar technology to the terahertz frequency range. Section 2 will discuss the structure, fabrication and performance of state-of-the-art planar Schottky diodes. In Section 3 the problems of designing and fabricating planar diodes for terahertz frequency operation are discussed along with a number of viable solutions. Section 4 summarizes the need for further research and cooperation between diode designers and RF engineers. Derived from text

N93-27777*# Michigan Univ., Ann Arbor. NASA Center for Space Terahertz Technology.

PLANAR DOPED BARRIER SUBHARMONIC MIXERS **c33**

T. H. Lee, J. R. East, and G. I. Haddad *In its* The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 616-630 (For primary document see N93-27726 10-31)

Avail: CASI HC A03/MF A06

The Planar Doped Barrier (PDB) diode is a device consisting of a p(+) doping spike between two intrinsic layers and n(+) ohmic contacts. This device has the advantages of controllable barrier height, diode capacitance and forward to reverse current ratio. A symmetrically designed PDB has an anti-symmetric current vs. voltage characteristic and is ideal for use as millimeter wave subharmonic mixers. We have fabricated such devices with barrier heights of 0.3, 0.5 and 0.7 volts from GaAs and InGaAs using a multijunction honeycomb structure with junction diameters between one and ten microns. Initial RF measurements are encouraging. The 0.7 volt barrier height 4 micron GaAs devices were tested as subharmonic mixers at 202 GHz with an IF frequency of 1 GHz and had 18 dB of conversion loss. The estimated mismatch loss was 7 dB and was due to higher diode capacitance. The LO frequency was 100.5 GHz and the pump power was 8 mW. Author (revised)

N93-27778*# Technische Hochschule, Darmstadt (Germany). Inst. fuer Hochfrequenztechnik.

NEW APPROACH TO THE DESIGN OF SCHOTTKY BARRIER DIODES FOR THz MIXERS **c33**

A. Jelenski (Polish Academy of Sciences, Warsaw.), A. Grueb, V. Krozer, and H. L. Hartnagel *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 631-642 (For primary document see N93-27726 10-31)

Avail: CASI HC A03/MF A06

Near-ideal GaAs Schottky barrier diodes especially designed for mixing applications in the THz frequency range are presented. A diode fabrication process for submicron diodes with near-ideal electrical and noise characteristics is described. This process is based on the electrolytic pulse etching of GaAs in combination with an in-situ platinum plating for the formation of the Schottky contacts. Schottky barrier diodes with a diameter of 1 micron fabricated by the process have already shown excellent results in a 650 GHz waveguide mixer at room temperature. A conversion loss of 7.5 dB and a mixer noise temperature of less than 2000 K have been obtained at an intermediate frequency of 4 GHz. The optimization of the diode structure and the technology was possible due to the development of a generalized Schottky barrier diode model which is valid also at high current densities. The common diode design and optimization is discussed on the basis of the classical theory. However, the conventional fomulas are valid only in a limited forward bias range corresponding to currents much smaller than the operating currents under submillimeter mixing conditions. The generalized new model takes into account not only the phenomena occurring at the junction such as current dependent recombination and drift/diffusion velocities, but also mobility and electron temperature variations in the undepleted epi-layer. Calculated diode I/V

and noise characteristics are in excellent agreement with the measured values. Thus, the model offers the possibility of optimizing the diode structure and predicting the diode performance under mixing conditions at THz frequencies. Author

N93-27779*# National Inst. of Standards and Technology, Boulder, CO. Electromagnetic Technology Div.

ELECTRICAL AND INFRARED PROPERTIES OF THIN NIOBIUM MICROBOLOMETERS NEAR T(SUB c) **c33**

E. N. Grossman, J. E. Sauvageau, and D. G. McDonald *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 643-653 Sponsored in part by Strategic Defense Initiative Organization (For primary document see N93-27726 10-31)

Avail: CASI HC A03/MF A06

Niobium microbolometers approximately 1 micron wide x 2 micron long x 10 nm thick have been integrated at the feeds of equiangular spiral antennas made of 200 nm thick Nb. The device's current-voltage characteristics and infrared responsivity as a function of DC bias voltage were measured over a range of temperature spanning approximately plus or minus 2 percent around T(sub c). The greatest voltage responsivity occurs well below T(sub c), in a regime where the I-V curve is significantly hysteretic due to self-heating and resembles the I-V curve of a superconducting microbridge. Author

N93-27780*# Bremen Univ. (Germany). Inst. of Remote Sensing.

MEASUREMENTS OF THE SINGLE SIDEBAND SUPPRESSION FOR A 650 GHz HETERODYNE RECEIVER **c33**

S. Crewell and H. Nett *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 654-660 (For primary document see N93-27726 10-31)

Avail: CASI HC A02/MF A06

A large number of atmospheric trace gases, involved in the process of stratospheric ozone depletion, show emission features in the submillimeter wavelength range (lambda = 0.1-1mm). High-resolution heterodyne techniques are a particularly useful tool in this spectral region as vertical distribution of these species can be deduced. Here the receiver has to be operated in the single sideband (ssb) mode preferably to avoid any interferences between the contributions in both receiver sidebands. In the 625-655 GHz heterodyne receiver developed at the University of Bremen a Martin-Puplett interferometer is used as a ssb-filter. A laboratory set-up has been built up to measure the performance of this interferometer. Author (revised)

N93-27781*# Virginia Univ., Charlottesville. Semiconductor Device Lab.

InGaAs/InP HETEROEPITAXIAL SCHOTTKY BARRIER DIODES FOR TERAHERTZ APPLICATIONS **c33**

Udayan V. Bhapkar, Yongjun Li, and Robert J. Mattauch *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 661-677 (For primary document see N93-27726 10-31)

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Avail: CASI HC A03/MF A06

This paper explores the feasibility of planar, sub-harmonically pumped, anti-parallel InGaAs/InP heteroepitaxial Schottky diodes for terahertz applications. We present calculations of the (I-V) characteristics of such diodes using a numerical model that considers tunneling. We also present noise and conversion loss predictions of diode mixers operated at 500 GHz, and obtained from a multi-port mixer analysis, using the I-V characteristics predicted by our model. Our calculations indicate that InGaAs/InP heteroepitaxial Schottky barrier diodes are expected to have an I-V characteristic with an ideality factor comparable to that of GaAs Schottky diodes. However, the reverse saturation current of InGaAs/InP diodes is expected to be much greater than that of GaAs diodes. These predictions are confirmed by experiment. The mixer analyses predict that sub-harmonically pumped anti-parallel InGaAs/InP diode mixers are expected to offer a 2 dB greater conversion loss and a somewhat higher single sideband noise temperature than their GaAs counterparts. More importantly, the InGaAs/InP devices are predicted to require only one-tenth of the local oscillator power required by similar GaAs diodes. Author

N93-27782*# California Univ., Berkeley. Dept. of Physics.

A BROADBAND THz RECEIVER FOR LOW BACKGROUND SPACE APPLICATIONS **c32**

C. Hagmann, D. J. Benford, A. C. Clapp, P. L. Richards, and P. Timbie *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 678-687 (For primary document see N93-27726 10-31)

(Contract NsG-7205; NAGw-2121; JPL-958764; NSF AST-88-09616)

Avail: CASI HC A02/MF A06

We have developed a sensitive bolometric receiver for low background space applications. In a 10 percent bandwidth at 1 THz, this receiver is approximately 100 times more sensitive than a quantum limited heterodyne receiver with a 1 GHz IF bandwidth. This receiver is designed to be used for the long wavelength band (200-700 microns) in the MIPS instrument on NASA's SIRTF satellite. The bolometers are cooled to 100 mK by an adiabatic demagnetization refrigerator. Roughly 60 g of cesium chrome alum salt is partially demagnetized to 100 mK, followed by a slow regulated downramp to compensate for the heat leak. The hold time of the ADR system is about 18 hours with a temperature stability of delta T(sub rms) approx. equals 10 micro-K. The composite bolometers have electrical responsivities of 10(exp 9)V/W and electrical NEP's of about 3x10(exp -17) W/square root of Hz. The bolometer signals are read out by JFET preamplifiers located on the helium plate and operated at 120 K. We have addressed a number of space qualification issues, such as the development of an analog magnet controller, construction of a cryogenic shake-table for bolometers and selection of the paramagnetic salt CCA which can survive a bakeout at 50 C. The receiver is scheduled to be flown in the spring of 1992 on a balloon telescope. This flight has a dual purpose. One is to provide realistic test of the capabilities of the new receiver. The other is to search for anisotropies in the cosmic microwave background on scales of a few degrees. Author (revised)

N93-27783*# Massachusetts Univ., Amherst. Dept. of Electrical and Computer Engineering.

AlGaAs/GaAs QUASI-BULK EFFECT MIXERS: ANALYSIS AND EXPERIMENTS **c33**

K. S. Yngvesson, J.-X. Yang, F. Agahi, D. Dai, C. Musante, W. Grammer, and K. M. Lau *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 688-705 (For primary document see N93-27726 10-31)

(Grant NAGw-1659)

Avail: CASI HC A03/MF A06

The lowest noise temperature for any receiver in the 0.5 to 1 THz range has been achieved with the bulk InSb hot electron mixer, which unfortunately suffers from the problem of having a very narrow bandwidth (1-2 MHz). We have demonstrated a three order of magnitude improvement in the bandwidth of hot electron mixers, by using the two-dimensional electron gas (2DEG) medium at the hetero-interface between AlGaAs and GaAs. We have tested both inhouse MOCVD-grown material, and MBE materials, with similar results. The conversion loss (L(sub c)) at 94 GHz is presently 18 dB for a mixer operating at 20 K, and calculations indicate that L(sub c) can be decreased to about 10 dB in future devices. Calculated and measured curves of L(sub c), versus PLO and IDC, respectively, agree well. We argue that there are several different configurations of hot electron mixers, which will also show wide bandwidth, and that these devices are likely to become important as low-noise THz receivers in the future. Author (revised)

N93-27784*# Radiometer-Physics G.m.b.H., Meckenheim (Germany).

ALL-SOLID-STATE RADIOMETERS FOR ENVIRONMENTAL STUDIES TO 700 GHz **c33**

Ralph Zimmermann, Ruediger Zimmermann, and Peter Zimmermann *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 706-723 (For primary document see N93-27726 10-31)

Avail: CASI HC A03/MF A06

We report results with an all-solid-state radiometer for measurements of the ClO molecule at 649 GHz. The project is part of a program to provide low-noise, low-weight, low-power radiometers for space operation, and special effort has been expended on the development of high-efficiency solid-state frequency multipliers and Schottky-barrier mixers with low local oscillator power requirements. The best measured system noise temperature

was 1750 K with the mixer and preamplifier cooled to 77 K. The mixer diode was easily pumped into saturation, indicating that the design has excellent prospects of operating at higher frequencies - our present design goal being 1 THz. We comment on the principal design features of such systems and will report on stratospheric measurements performed with this system. Author

N93-27785*# Cologne Univ. (Germany). Physikalisches Inst.
A 492 GHz COOLED SCHOTTKY RECEIVER FOR RADIO-ASTRONOMY c89
J. Hernichel, R. Schieder, J. Stutzki, B. Vowinkel, G. Winnewisser, and Peter Zimmermann *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 724-730 Sponsored in part by BMFT (For primary document see N93-27726 10-31)
(Contract DFG-SFB-301)
Avail: CASI HC A02/MF A06

We developed a 492 GHz cooled GaAs Schottky receiver driven by a solid state local oscillator with a DSB noise temperature of 550 K measured at the telescope. The receiver-bandwidth is approx. equal to 1.0 GHz. Quasi-optical mirrors focus the sky and local oscillator radiation into the mixer. Stability analysis via the Allan variance method shows that the total system including a 1 GHz bandwidth acousto-optical spectrometer built in Cologne allows integration times up to 100 sec per half switching cycle. We successfully used the receiver at the KOSMA 3 m telescope on Gornergrat (3150m) located in the central Swiss Alps near Zermatt during January-February 1992 for observations of the 492 GHz, (CI) (3)P1 to (3)P0 fine structure line in several galactic sources. These observations confirm that Gornergrat is an excellent winter submillimeter site in accordance with previous predictions based on the atmospheric opacity from KOSMA 345 GHz measurements. Author (revised)

N93-27853# Admiralty Research Establishment, Gosport (England).
HMS SPEEDY: SEAKEEPING TRIALS, 25 FEBRUARY TO 1 MARCH 1982
R. E. Small Dec. 1984 24 p
(ARE-AMTE(H)-R84117; BR94138; ETN-93-93783) Copyright Avail: CASI HC A03/MF A01

The results of seakeeping trials carried out on HMS Speedy off the Eddystone Lighthouse (off Plymouth, English Channel, UK) in sea states 4 and 5 are presented. The craft was capable of remaining foilborn throughout, and with the exception of longitudinal acceleration, the motions and accelerations experienced were higher when hullborn. The hydrofoil is concluded to be an extremely stable platform in the foilborn mode. It is capable of operating with 'hands off' under the control of the automatic control system up to and including sea state 4, although manual override is sometimes necessary. In sea state 5 with manual control HMS Speedy can operate with very little loss of speed (usually in excess of 40 knots). ESA

N93-28136*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
GAS STORAGE AND RECOVERY SYSTEM Patent Application
Joseph S. Cook, inventor (to NASA) 23 Mar. 1993 17 p
(NASA-Case-MSC-22091-1; NAS 1.71:MSC-22091-1;
US-Patent-Appl-SN-039602) Avail: CASI HC A03/MF A01

A system for recovering and recycling gases is disclosed. The system is comprised of inlet and outlet flow lines, controllers, an inflatable enclosure, and inflatable rib stiffeners which are inflatable by the gas to be stored. The system does not present gas at an undesirable back pressure to the gas source. A filtering relief valve is employed which prevents environmental airborne contamination from flowing back into the system when the relief valve is closing. The system is for storing and re-using helium. NASA

N93-28372# Sandia National Labs., Albuquerque, NM. Advanced Microelectronics Packaging Dept.
A MASKLESS FLIP-CHIP SOLDER BUMPING TECHNIQUE
Dahwey Chu and David S. Shen 1992 6 p Presented at the 43rd Electronic Component and Technology Conference, Orlando, FL, 1-3 Jun. 1993
(Contract DE-AC04-76DP-00789)
(DE93-009631; SAND-92-2365C; CONF-9306104-4) Avail: CASI HC A02/MF A01

Conventional flip-chip solder bumping, utilizing masks, evaporation, and plating equipment, is ideally suited for the mass production of components. Large batches of wafers can be deposited with multilayer solder at a single time. However, this process can be excessively costly, time consuming, and unnecessary for small, specialized applications. A process was developed to solder bump individual pads, one at a time, without the need for expensive masks, evaporation chambers, or die layout information. This information, critical for solder bump placement, is typically not available to sources outside the design house. Using a standard ball wirebonder and specialized bonding wire, solder bumps can be formed on both Al and Au bond pads of integrated circuits (IC) using thermosonic bonding in a forming gas (Hydrogen-Argon) atmosphere. The bonding effectively wets the solder bump to the pad without the use of special intermetallic adhesion layers. This process can cut prototyping time and cost by eliminating the need for elaborate equipment and complex solder compositions without sacrificing electrical or thermal performance. DOE

N93-26683*# Arizona Univ., Tucson. Dept. of Aerospace and Mechanical Engineering.
OXYGEN PRODUCTION ON MARS AND THE MOON
K. R. Sridhar, B. Vaniman, and S. Miller *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 15 p (For primary document see N93-26674 10-91)
Avail: CASI HC A03/MF A03; 1 functional color page

N93-26687*# Arizona Univ., Tucson. Dept. of Civil Engineering and Engineering Mechanics.
DEVELOPMENT AND MECHANICAL PROPERTIES OF CONSTRUCTION MATERIALS FROM LUNAR SIMULANT
Chandra S. Desai *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 12 p (For primary document see N93-26674 10-91)
Avail: CASI HC A03/MF A03; 1 functional color page

N93-26693*# Arizona Univ., Tucson. Dept. of Electrical and Computer Engineering.
MODELING, SIMULATION, AND HIGH-AUTONOMY CONTROL OF A MARTIAN OXYGEN PRODUCTION PLANT
L. C. Schooley, F. E. Cellier, F.-Y. Wang, and B. P. Zeigler *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 20 p (For primary document see N93-26674 10-91)
Avail: CASI HC A03/MF A03; 1 functional color page

N93-26694*# Arizona Univ., Tucson. Dept. of Aerospace and Mechanical Engineering.
DEVELOPMENT OF A MATERIAL PROCESSING PLANT FOR LUNAR SOIL
Ulix Goettsch and Karl Ousterhout *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 9 p (For primary document see N93-26674 10-91)
Avail: CASI HC A02/MF A03; 1 functional color page

N93-26696*# Arizona Univ., Tucson. NASA Space Engineering Research Center.
FULL SYSTEM ENGINEERING DESIGN AND OPERATION OF AN OXYGEN PLANT
James Colvin, Paul Schallhorn, and Kumar Ramonhalli *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 17 p (For primary document see N93-26674 10-91)
Avail: CASI HC A03/MF A03; 1 functional color page

N93-27972*# Boeing Defense and Space Group, Seattle, WA.
LUNAR MATERIALS PROCESSING SYSTEM INTEGRATION
Brent Sherwood *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 13 p (For primary document see N93-27956 10-91)
Avail: CASI HC A03/MF A03

N93-27973*# Aerojet TechSystems Co., Sacramento, CA.
ON-SITE MANUFACTURE OF PROPELLANT OXYGEN FROM LUNAR RESOURCES
Sanders D. Rosenberg *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 11 p (For primary document see N93-27956 10-91)
Avail: CASI HC A03/MF A03

N93-27975*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
ENGINEERING DESIGN CONSTRAINTS OF THE LUNAR SURFACE ENVIRONMENT Abstract only
D. A. Morrison *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 2 p (For primary document see N93-27956 10-91)
Avail: CASI HC A01/MF A03

N93-27986*# New York Univ., New York.
RECTENNA THERMAL MODEL DEVELOPMENT
Murall Kadiramangalam, Adrian Alden (Communications Research Centre, Ottawa, Ontario.), and Daniel Speyer *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 13 p (For primary document see N93-27956 10-91)
Avail: CASI HC A03/MF A03

32 COMMUNICATIONS AND RADAR

Includes radar; land and global communications; communications theory; and optical communications.

For related information see also *04 Aircraft Communications and Navigation* and *17 Space Communications, Spacecraft Communications, Command and Tracking.* For search and rescue see *03 Air Transportation and Safety,* and *16 Space Transportation.*

N93-26629# ElectroMagnetic Applications, Inc., Boston, MA.
DEVELOPMENT OF NOVEL FERRITE ANTENNAS Final Report, 28 Aug. 1992 - 28 Feb. 1993
Hoton How 1 Mar. 1993 78 p
(Contract DASG60-92-C-0206)
(AD-A261690) Avail: CASI HC A05/MF A01

We have performed and successfully completed a phase 1 study involving an isolated ferrite patch antenna possessing a circular or a rectangular geometry. The radiation frequencies measured as a function of the biasing magnetic field compared quantitatively with our theory. Measurements on the radiation patterns confirmed the nature of the normal modes of the patch antennas. Ferrite patch antennas may be used for the following purposes: generation of circularly polarized radiations, wide frequency tuning range for single model application, and RCS reduction on patch antennas.
DTIC

N93-26640# Ministry of Communications, Seoul (Republic of Korea).
THE 1992 UNITED NATIONS WORKSHOP ON SPACE COMMUNICATION FOR DEVELOPMENT: PROCEEDINGS
Korea Society of Space Technology 1992 378 p Workshop held in Seoul, Republic of Korea, 24-27 Nov. 1992 Sponsored by UN Original contains color illustrations
Avail: CASI HC A17/MF A03

The focus of the conference was on space communications for development, particularly in the Asia-Pacific region. Various papers are presented, and the topics covered include the following: mobile communication systems, television transmission, high definition television, wireless communication, satellite communication, communication satellites, the Advanced Communications Technology Satellite (ACTS); satellite networks; digital communication; and transponders. For individual titles, see N93-26641 through N93-26664.

N93-26641# Tongasat, Nuku 'Alofa (Tonga).
CURRENT TRENDS AND PROSPECTS OF TELECOMMUNICATIONS SERVICE DEMAND BY SATELLITE IN THE ASIA-PACIFIC REGION
Mats C. Nilson *In* Ministry of Communications, The 1992 United Nations Workshop on Space Communication for Development: Proceedings 1992 p 23-35 (For primary document see N93-26640 10-32)
Avail: CASI HC A03/MF A03

The topics are presented in viewgraph form and include the following: existing satellite systems serving Asia-Pacific; regional capacity supply for the 1990's; planned satellite systems for Asia-Pacific; regional systems announced for service in 1994-1997; categories of service demand via satellite;and demand forecasts for Asia-Pacific. Author (trans.)

N93-26642# International Maritime Satellite Organization, London (England).
PROJECT 21: A NEW RANGE OF PERSONAL MOBILE SATELLITE SERVICES
Jai Singh *In* Ministry of Communications, The 1992 United Nations Workshop on Space Communication for Development: Proceedings 1992 p 37-55 (For primary document see N93-26640 10-32)
Avail: CASI HC A03/MF A03

Project 21 is Inmarsat's overall vision and strategy for the development of personal mobile satellite communications systems from now into the 21st Century. Using advances in mobile satellite services and technology, it is aimed at introducing a range of affordable, increasingly portable and convenient, global personal mobile satellite communication services throughout the decade. The culmination of Project 21 will be the introduction of Inmarsat-P service to a portable hand-held terminal by means of a new, more powerful, satellite generation dubbed P-Sats. This paper describes the four main service elements of the Project 21 program: Inmarsat-C, a portable mobile satellite data service introduced in 1991; Inmarsat-M, a briefcase-sized, digital, satellite phone being introduced in the coming months; global satellite paging scheduled for service introduction in 1994; and Inmarsat-P, in planning for introduction in 1998-2000 time-frame. The Inmarsat-P terminal is envisaged as a dual-mode satellite-cellular terminal that will work with a cellular system or from the satellite when out of home region cellular coverage, or operating from a region with a different cellular standard or without roaming arrangements. Inmarsat-P will offer line-of-sight satellite service, with a voice quality similar to that of digital cellular systems. To support Inmarsat-P services, a new generation of Inmarsat satellites would be required. A number of advanced satellite system and orbit configurations are potential candidates to provide the required coverage and capacity for global handheld satellite phone services. The paper describes some of the system considerations that need to be further addressed in order to select the most optimal P-Sat system design.
Author

N93-26643# General Electric Co., Princeton, NJ. Astro-Space Div.
THE ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE (ACTS): FIVE NEW TECHNOLOGIES
F. Gargione *In* Ministry of Communications, The 1992 United Nations Workshop on Space Communication for Development: Proceedings 1992 p 57-76 (For primary document see N93-26640 10-32)
Avail: CASI HC A03/MF A03

The topics are presented in viewgraph form and include the following: ACTS program objectives; an overview of ACTS flight segment; an overview of ACTS ground segment; spacecraft configuration; ACTS spacecraft characteristics; ACTS new technologies; ACTS multibeam communication system block diagram; ACTS multibeam antenna characteristics; ACTS multibeam antenna coverage; electronically hopping beams; on-board switching; baseband processor mode; microwave switch matrix mode; Ka-band transponder characteristics; rain fade compensation; propagation beacons; ACTS spacecraft status; ACTS experimenter terminal categories; and ACTS system operations.
CASI

N93-26644# Iridium, Inc., Washington, DC. Business Operations.
IRIDIUM: COVERING THE GLOBE WITH PERSONAL COMMUNICATION
Mark Gercenstein *In* Ministry of Communications, The 1992 United Nations Workshop on Space Communication for Development: Proceedings 1992 p 77-91 (For primary document see N93-26640 10-32)
Avail: CASI HC A03/MF A03

It has become abundantly clear that available, reliable telecommunications is a critical requirement for effective economic development, and that most of the worlds population lacks effective telecommunications today, even on a local basis, with international capability being particularly deficient.

The IRIDIUM system, a satellite based communications system utilizing Low Earth Orbit (LEO) satellites, will bring personal communications to every part of the world. This networked LEO system will provide an efficient means of interconnecting hundreds of thousands of towns and villages more cost effectively than any other known approach. Various aspects of the system are discussed. Derived from text

N93-26645# Japan Broadcasting Corp., Tokyo. Science and Technical Research Labs.

DIGITAL AUDIO AND VIDEO BROADCASTING BY SATELLITE

Takehiko Yoshino *In* Ministry of Communications, The 1992 United Nations Workshop on Space Communication for Development: Proceedings 1992 p 93-101 (For primary document see N93-26640 10-32)

Avail: CASI HC A02/MF A03

In parallel with the progress of the practical use of satellite broadcasting and Hi-Vision or high-definition television technologies, research activities are also in progress to replace the conventional analog broadcasting services with a digital version. What we call 'digitalization' is not a mere technical matter but an important subject which will help promote multichannel or multimedia applications and, accordingly, can change the old concept of mass media, such as television or radio. NHK Science and Technical Research Laboratories has promoted studies of digital bandwidth compression, transmission, and application techniques. The following topics are covered: the trend of digital broadcasting; features of Integrated Services Digital Broadcasting (ISDB); compression encoding and transmission; transmission bit rate in 12 GHz band; number of digital TV transmission channels; multichannel pulse code modulation (PCM) audio broadcasting system via communication satellite; digital Hi-Vision broadcasting; and development of digital audio broadcasting (DAB) for mobile reception in Japan. Derived from text

N93-26646# Kokusai Denshin Denwa Co. Ltd., Tokyo (Japan).

MOBILE COMMUNICATION VIA SATELLITE TOWARDS THE YEAR 2000

Yasuo Hirata *In* Ministry of Communications, The 1992 United Nations Workshop on Space Communication for Development: Proceedings 1992 p 103-111 (For primary document see N93-26640 10-32)

Avail: CASI HC A02/MF A03

Recently, mobile communication services are dramatically growing, and there is an ever increasing demand for these services. INMARSAT (International Maritime Satellite Organization) plays a very important role to establish mobile communication networks for ships and airplanes on the global basis. For personal mobile communication, INMARSAT is currently studying INMARSAT-P hand-held terminal in its Project 21. Several mobile satellite communication systems such as IRIDIUM and Globalstar systems are also proposed in order to realize personal communication services towards the 21st century. This paper presents a recent trend of mobile satellite communication systems mainly aiming at the realization of personal communication services. Activities of CCIR (International Radio Consultative Committee) and major results of WARC (World Administrative Radio Conference) '92 are also briefly introduced focusing on mobile satellite matters. Derived from text

N93-26647# SOVCAN STAR Satellite Communications, Inc., Krasnoyarsk (Russia).

SOVCAN STAR: AN INTERNATIONAL SATELLITE SYSTEM

Valery A. Skatchkov *In* Ministry of Communications, The 1992 United Nations Workshop on Space Communication for Development: Proceedings 1992 p 113-125 Prepared in cooperation with SOVCAN STAR Satellite Communications, Inc., Montreal, Quebec and SOVCAN STAR Satellite Communications, Inc., Ottawa, Ontario (For primary document see N93-26640 10-32)

Avail: CASI HC A03/MF A03

SOVCAN STAR is a Russian-Canadian cooperative venture company formed to manufacture, test, launch and operate a Ku-band satellite system. Drawing on the more than twenty years communications satellite experience of the founding companies, the SOVCAN STAR satellites are being designed to be competitive and cost effective. They will be equipped with 24 transponders and four steerable antennas. The design allows the operators to switch individual transponders between the various antenna coverage beams. These satellites will offer a high degree of operational flexibility and performance. The SOVCAN STAR strategy is to develop a network of satellites in parallel with the growth and evolution of the traffic requirements. Such an approach minimizes the technical, schedule and program risks while at the same time significantly reduces the financial exposure. The first SOVCAN STAR satellite will be commissioned in 1996 and operated at 14 deg W. The beams will be aligned to North America and Europe offering International service between Canada, the Eastern U.S.A., Europe, Russia and the Western C.I.S. Republics. The second SOVCAN STAR satellite will be commissioned a year later and operated at 145 deg E. This satellite will cover the Western Pacific Ocean, Eastern Asia and Australasia. Author

N93-26648# International Maritime Satellite Organization, London (England). Aeronautical Services Div.

SATELLITE COMMUNICATIONS FOR AERONAUTICAL AND NAVIGATION SERVICE

Richard Smith *In* Ministry of Communications, The 1992 United Nations Workshop on Space Communication for Development: Proceedings 1992 p 131-139 (For primary document see N93-26640 10-32)

Avail: CASI HC A02/MF A03

This paper describes the satellite-based systems to be used by the civil aviation community to meet the future communications, navigation and surveillance requirements for air traffic management over oceans and remote land areas, as well as for other aeronautical mobile communications purposes. Author

N93-26649# Telecommunicaion Co. of Iran, Tehran.

ZOHREH: THE IRANIAN DOMESTIC SATELLITE SYSTEM

M. H. Harati *In* Ministry of Communications, The 1992 United Nations Workshop on Space Communication for Development: Proceedings 1992 p 141-153 (For primary document see N93-26640 10-32)

Avail: CASI HC A03/MF A03

This document describes the general characteristics of the space segment and the ground support system together with the plans foreseen for the present and future expansion of a domestic satellite ground network in Iran. The aim of this presentation is to identify and explain the needs and requirements of a domestic satellite system and also to overview briefly the technical specification of the Zohreh Project. Author (revised)

N93-26650# China Telecommunications Broadcast Satellite Co., Lasa.

SATELLITE COMMUNICATION SERVICES FOR TIBET AUTONOMOUS REGION BY DOMESTIC SATELLITE IN CHINA

Bao-Kun Wu *In* Ministry of Communications, The 1992 United Nations Workshop on Space Communication for Development: Proceedings 1992 p 155-163 (For primary document see N93-26640 10-32)

Avail: CASI HC A02/MF A03

This article describes the factors to be considered, the type-selecting principles and the refinement of the prototype in construction of the Tibet thin-route satellite telecommunication network. Western China is the cradle of the culture and economic development of the country. It has vast territory, abundant resources and great potential. The application of satellite communication technology in our country has been rather recent in the western area, and the system is being perfected and extended continuously. In order to solve the problems in country-country telephone communication in Tibet, the government began to build a thin-route voice VSAT (Voicesat) network which consists of 58 terminal stations in Tibet this year. Before long, this voicesat network will be extended into the territory of Xinjiang, Inner Mogolia, Sichuan and Qinghai, it will connect the important cities and counties located in the area of several million square kilometers. Author (revised)

N93-26651# Korea Telecom Satellite Business Group, Seoul (Republic of Korea). Satellite Business Group.

MUGUNGHWA: THE FIRST KOREAN DOMESTIC SATELLITE FOR FSS AND DBS SERVICES

Han Hwangbo *In* Ministry of Communications, The 1992 United Nations Workshop on Space Communication for Development: Proceedings 1992 p 165-174 (For primary document see N93-26640 10-32)

Avail: CASI HC A02/MF A03

Mugunghwa is the first generation satellite for the Republic of Korea. It uses the advanced digital technology for direct broadcasting and fixed satellite services in Korea. It will provide basic satellite communications

facilities with small low-cost remote stations for rural and remote areas presently having inadequate or no telecommunication facilities. It will also provide high speed data and video distributions for business television and other professional program services such as tele-educational video networks. High quality color television and high definition TV services will also be available anywhere in Korea. Author

N93-26652# Ministry of Posts and Telecommunications, Tokyo (Japan). Space Communication Research Office.

JAPANESE EXPERIMENTS FOR MEDICAL AND EDUCATIONAL BROADCASTS BY KIKU SATELLITE (PARTNERS PROJECT USING ETS-V)

Yuji Onishi *In* Ministry of Communications, The 1992 United Nations Workshop on Space Communication for Development: Proceedings 1992 p 175-181 (For primary document see N93-26640 10-32)

Avail: CASI HC A02/MF A03

The Ministry of Posts and Telecommunications (MPT), the National Space Development Agency (NASDA), and others have proposed joint space communication experiments based on the Engineering Test Satellite ETS-V. This joint international project is registered as the Peacesat Expansion / Pan-Pacific Information Network at the United Nations Space Agency Forum for the International Space Year. To make the project more recognizable, it was renamed PARTNERS (Pan-Pacific Regional Telecommunication Network Research Satellite) Project. Under the project, researchers in Japan and developing countries will perform experiments aimed at verifying satellite use technologies. The experiments are intended to promote international cooperation by providing an opportunity for technology transfer and exchange. Derived from text

N93-26653# Globalstar, Palo Alto, CA.

WORLDWIDE SEAMLESS CELLULAR SATELLITE COMMUNICATIONS: THE GLOBAL MOBILE COMMUNICATION BY GLOBALSTAR SYSTEM

Anthony J. Navarra (Qualcomm, Inc., San Diego, CA.) *In* Ministry of Communications, The 1992 United Nations Workshop on Space Communication for Development: Proceedings 1992 p 183-196 (For primary document see N93-26640 10-32)

Avail: CASI HC A03/MF A03

Presentation viewgraphs are presented that describe the need and technology requirements for a worldwide cellular satellite communication system. Specific services provided by such a system are outlined and the role of the service provider is described. CASI

N93-26654# PanAmSat, Greenwich, CT. Market Development and Regulatory Affairs.

SATELLITE COMMUNICATIONS SERVICE: LEASED OR OWNED TRANSPONDERS ON DOMESTIC, REGIONAL, OR GLOBAL SATELLITE SYSTEMS?

Gregg Daffner *In* Ministry of Communications, The 1992 United Nations Workshop on Space Communication for Development: Proceedings 1992 p 201-205 (For primary document see N93-26640 10-32)

Avail: CASI HC A01/MF A03

Today when we discuss satellite systems in a worldwide arena, the focus is no longer on just providing services to individual national markets. A truly global perspective means looking past the artificial restrictions of geographic boundaries and recognizing one large international marketplace. Therefore, in the realm of worldwide space communications, systems limited solely to the provision of domestic or even regional services may no longer be viable. Nonetheless, the construction and operation of a dedicated satellite system is a financially and technically risky investment. Satellite systems have high fixed costs and limited lives. Unless users are committed prior to launch, there is the financial risk of having to carry transponders as in-orbit inventory, as well as the risk that the transponder design will not meet customer demands. Several other aspects of global satellite communication systems are discussed. These other aspects include the following: global markets, technology access, start-up costs, carrying costs, and risk. Author

N93-26655# International Communications Corp., Manila (Philippines).

DATA COMMUNICATIONS SERVICE BY VSAT NETWORK IN THE PHILIPPINES

Roberto L. Duque *In* Ministry of Communications, The 1992 United Nations Workshop on Space Communication for Development: Proceedings 1992 p 207-219 (For primary document see N93-26640 10-32)

Avail: CASI HC A03/MF A03

Satellite communications is of particular importance to an archipelago like the Philippines. With over 7,100 islands, rugged forests, and mountainous terrain, satellite communications technology offers the opportunity to leapfrog over the existing difficulties associated with terrestrial-based microwave networks. If harnessed correctly, it has the potential to significantly contribute to the provisions of a wide array of services ranging from voice to facsimile and data to video. The continuous evolution of satellite and earth station technology, since its inception more than 30 years ago, has placed within reach technologies which are reliable as well as easily deployed, used, and maintained. The Philippine government's recognition of the vital role of wireless communications was never more evident than during and after the series of natural calamities that hit the country and disrupted existing microwave infrastructure. Aside from obvious technological advantages over conventional communications technologies, satellite communications provides cost-effective solutions and fortifies the country's unstable communications infrastructure. Author (revised)

N93-26656# Department of Civil Protection (Italy).

MANAGEMENT OF THE DISASTER COMMUNICATIONS BY SATELLITE

Guido Martinelli *In* Ministry of Communications, The 1992 United Nations Workshop on Space Communication for Development: Proceedings 1992 p 221-235 (For primary document see N93-26640 10-32)

Avail: CASI HC A03/MF A03

Experiences during various natural disasters have prompted the Italian Department for Civil Protection to examine available communication technologies in the hope of establishing a communication system which carry out Command, Control, and Coordination functions during an emergency. This paper explains why satellite communication was chosen to fulfill this role. Author (revised)

N93-26657# Vietnam Telecom International.

COMMUNICATION SERVICE BY SATELLITE LINK IN VIETNAM

Ngo De *In* Ministry of Communications, The 1992 United Nations Workshop on Space Communication for Development: Proceedings 1992 p 237-239 (For primary document see N93-26640 10-32)

Avail: CASI HC A01/MF A03

At the present time in Vietnam, many projects are underway to develop communications transmission methods such as terrestrial optical fiber, submarine optical fiber, and broadband microwave. However, due to its level of efficiency, the development of satellite communications networks is considered to be the long term goal of DGPT Vietnam, for both domestic and international telecommunication services. Derived from text

N93-26658# Morsvyazsputnik, Moscow (Russia).

COSPAS-SARSAT SYSTEM: PRESENT OPERATION AND DEVELOPMENT

Y. G. Zurabov and V. N. Terekhin *In* Ministry of Communications, The 1992 United Nations Workshop on Space Communication for Development: Proceedings 1992 p 243-259 (For primary document see N93-26640 10-32)

Avail: CASI HC A03/MF A03

The COSPAS-SARSAT international satellite system is intended for the search and the determination of the location of vessels and aircraft in distress. It was created through the cooperation of four countries--USSR, USA, Canada, and France. The international cooperation that led to the system's creation began at a bilateral meeting of Soviet and American experts, held in Washington in Mar. 1977. At the meeting, a Protocol between the Ministry of the Merchant Marine of the USSR and the National Aeronautics and Space Administration (NASA) of the USA was signed. This protocol reflected the hopes of both countries of performing a joint international experiment that would examine the possibility of using American and Soviet artificial satellites in search and rescue roles. The paper presents and overview of the COSPAS-SARSAT system's development. Derived from text

N93-26659# Telekomunikasi Indonesia P.T., Jakarta.

THE NEXT GENERATION OF PALAPA SATELLITE (PALAPA-C)

Bambang Setiawan *In* Ministry of Communications, The 1992 United Nations Workshop on Space Communication for Development:

Proceedings 1992 p 263-274 (For primary document see N93-26640 10-32)
Avail: CASI HC A03/MF A03

The Indonesian Palapa Communication Satellite System was established in Aug. 1976 when the first satellite of Palapa A series (Palapa A1) began operation. The system is owned and operated by PT. Telekomunikasi Indonesia (Telkom), which is a state owned company. The purpose of the system was to unify the telecommunications of the nation. Many years of operation have shown that satellite technology is the best solution for improving telecommunications in Indonesia. The system was started with 2 (two) satellites, each with 12 transponders (for a total of 24), and 40 earth stations. Now the system has 3 (three) satellites, each with 24 transponders (for a total of 72 transponders), and thousands of earth stations. The services have been extended to satisfy the requirements of the region as well as the original objectives. The use of satellite transponders in the region is increasing rapidly. In the next ten years, opportunities in the satellite communications business will become even more attractive. The next generation Palapa-C will incorporate improvements in capacity, quality, and coverage. The new frequency bands (ku- and Extended-C Band) will be used to meet the new transponder capacity requirements.
Derived from text

N93-26660# Alenia Spazio S.p.A., Turin (Italy). Ground Systems Div.
DIGITAL TELECOMMUNICATIONS ARE A KEY DEVELOPMENT FACTOR: INTEGRATION OF SATELLITE INTO OVERALL TELECOMMUNICATION NETWORKS AS A WAY TO HARMONIZE SOCIAL AND ECONOMIC IMPLICATIONS
Raffaele Caracciolo *In* Ministry of Communications, The 1992 United Nations Workshop on Space Communication for Development: Proceedings 1992 p 275-317 (For primary document see N93-26640 10-32)
Avail: CASI HC A03/MF A03

Viewgraphs and discussions on digital telecommunications - a key development factor: integration of satellite into overall telecommunication networks as a way to harmonize social and economic implications are presented. Topics covered include: analysis of correlation between gross national product (GNP) and telephone density; analysis of potential lines increases vs. GNP; SESNET; corporate networks; and an integrated network concept.
CASI

N93-26661# Asia Satellite Telecommunications Co. Ltd. (Hong Kong).
TELECOMMUNICATION SERVICE BY LEASED TRANSPONDERS OF THE REGIONAL SATELLITE
Andrew Jordan *In* Ministry of Communications, The 1992 United Nations Workshop on Space Communication for Development: Proceedings 1992 p 319-324 (For primary document see N93-26640 10-32)
Avail: CASI HC A01/MF A03

Various telecommunications applications and services that can be provided by regional satellites are discussed. The potential for extending and enhancing Asia's telecommunications infrastructure is huge; and as Asian countries further develop economically, they will require the speed and power of satellites in order to develop their telecom and television broadcasting facilities quickly and economically. Topics discussed include emergence of regional satellite systems; services offered by regional satellites; rural telecommunication; trunk routes; international links; and television broadcasting.
Derived from text

N93-26662# Consortium for Educational Communication, New Delhi (India).
SATELLITE COMMUNICATION PROGRAMMES FOR RURAL EDUCATION AND DEVELOPMENT
Kiran Karnik *In* Ministry of Communications, The 1992 United Nations Workshop on Space Communication for Development: Proceedings 1992 p 337-360 (For primary document see N93-26640 10-32)
Avail: CASI HC A03/MF A03

In the space of three decades, the technology of satellite communication has notched up remarkable advances. Even more dramatic have been the range of its applications, and their impact. The reach of satellite communication, its ability to instantaneously link remote, far-flung and inaccessible areas, has been one of its major characteristics. Therefore, the contribution of this technology towards fostering development and education in rural areas is of special interest. Some uses of satellite communication for rural education and development in India are described. On the basis of an analysis of the Indian experience, some general lessons are discussed, many of which may be of relevance to other countries also.
Author (revised)

N93-26663# Overseas Telecommunications Commission, Sydney (Australia).
A COMMUNICATIONS SYSTEM FOR THE UNITED NATIONS TRANSITIONAL AUTHORITY IN CAMBODIA (UNTAC)
Ian J. DeMontfort *In* Ministry of Communications, The 1992 United Nations Workshop on Space Communication for Development: Proceedings 1992 p 361-384 (For primary document see N93-26640 10-32)
Avail: CASI HC A03/MF A03

Between Nov. 1991 and Feb. 1992, the United Nations Advance Mission in Cambodia (UNIMAC) established rudimentary military communications services covering administration and factional communications needs. UNIMAC's successor, United Nations Transitional Authority in Cambodia (UNTAC) was established in Mar. 1992 and is mandated to provide a range of services including a comprehensive commercial communications network. The development of this commercial communications network is discussed. The satellite system facilities, and operations and maintenance support are discussed.
Derived from text

N93-26664# Ministry of Transport and Communication, Bangkok (Thailand).
PRIVATIZATION OF DATA COMMUNICATION SERVICES BY DOMESTIC SATELLITE IN THAILAND
Rianchai Reowilaisuk *In* Ministry of Communications, The 1992 United Nations Workshop on Space Communication for Development: Proceedings 1992 p 385-399 (For primary document see N93-26640 10-32)
Avail: CASI HC A03/MF A03

A summary of privatization of satellite communication services in Thailand is presented. A background of satellite communication in Thailand is given. Satellite communication providers, both government and private, are listed. Steps toward privatization and laws governing telecommunications are addressed.
CASI

N93-26670# Sandia National Labs., Albuquerque, NM.
LOADED CAVITY-BACKED SLOT (LCBS) ANTENNAS FOR REENTRY VEHICLES
M. D. Sena Sep. 1992 37 p
(Contract DE-AC04-76DP-00789)
(DE93-008363; SAND-92-1472) Avail: CASI HC A03/MF A01

This report describes the linearly-polarized, loaded cavity-backed slot (LCBS) antenna developed for reentry vehicles (RV's) and the development process used by the Antenna Development Department. It includes typical antenna engineering design considerations or requirements, fabrication/assembly processes, and performance characteristics. Antenna design theory is reduced to the basic concepts useful in designing LCBS antennas for reentry vehicles.
DOE

N93-26903*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
SATELLITES AND THE BISDN: AN OVERVIEW OF NASA R/D
E. A. Bobinsky and W. D. Ivancic Nov. 1992 10 p Presented at the ISDN/Broadband 1992 Information Gatekeepers, Inc., Reston, VA, 16-20 Nov. 1992
(RTOP 144-10-10)
(NASA-TM-106108; E-7757; NAS 1.15:106108) Avail: CASI HC A02/MF A01

NASA is currently the only U.S. government agency developing advanced technology on behalf of the commercial communications satellite industry. The Agency's commercial communications program includes several activities which are either directly or indirectly related to the potential use of satellites within a broadband integrated services digital network (BISDN). Lewis Research Center's Space Electronics Division is actively pursuing a number of thrusts aimed at the integration of satellites into the BISDN through the development of high-risk and proof-of-concept technology.
Author

N93-27007 Department of the Navy, Washington, DC.
HIGH DATA RATE LONG PULSE COMPRESSION WAVEFORM COMMUNICATION SYSTEM FOR M-RAY ENCODING VOICE MESSAGES FOR AIR TRAFFIC CONTROL SYSTEMS Patent
William H. Waters, inventor (to Navy) and George J. Linde, inventor (to Navy) 13 Oct. 1992 14 p Filed 31 Jan. 1991 Supersedes AD-D014947
(AD-D015682; US-Patent-5,155,741; US-Patent-Appl-SN-648696; US-Patent-Class-375-1) Avail: US Patent and Trademark Office

A communications system which decreases noise errors and increases information rate without sacrificing bandwidth is formed by a transmitter and a receiver designed to handle long pulse compression waveforms. An encoder connected to the transmitter converts a voice message into digitized voice words, encodes the digitized voice works into time shifted code sequences, and phase modulates the long pulse compression waveform. DTIC

N93-27226# Technische Univ., Eindhoven (Netherlands). Telecommunications Div.
WIDE-ANGLE RADIATION PATTERN CALCULATION OF PARABOLOIDAL REFLECTOR ANTENNAS: A COMPARATIVE STUDY
J. Chen, P. J. I. deMaagt, and M. H. A. J. Herben Jun. 1991 148 p Sponsored by Chinese Government, and Chengdu Aircraft Co., China
(EUT-91-E-252; ISBN-9-06-144252-4; ETN-93-93157) Avail: CASI HC A07/MF A02

The complete radiation pattern of a symmetrical paraboidal reflector antenna is calculated by high frequency asymptotic techniques. These techniques are reviewed and the diffraction coefficients are compared. The angle regions in which these methods are valid are discussed and some associated conflicting statements in literature are cleared up. It is shown that the geometrical theory of diffraction is the most successful method to calculate the scattered field for reflector antennas in wide angle regions. The physical optics and the equivalent edge current methods are used. The results are in good agreement with theoretical and experimental work. The wide angle radiation pattern of an offset paraboloidal reflector antennas is calculated using the geometrical theory of diffraction method. It is shown that there are two far field caustics in the symmetry plane of the offset configuration: one in the antenna forward direction and one at a specific angle determined by the offset configuration. In the latter caustic region the equivalent edge current method is used. Outside the symmetry plane specific far field angles are found where geometrical theory of diffraction fails; this phenomenon is explained with the help of far field 'caustic' points. To obtain the complete power pattern, physical optics is used in the forward axial region. ESA

N93-27228# Technische Univ., Eindhoven (Netherlands). Electromagnetism and Circuit Theory Professional Group.
AN EFFICIENT METHOD FOR ANALYZING MICROSTRIP ANTENNAS WITH A DIELECTRIC COVER USING A SPECTRAL DOMAIN MOMENT METHOD
A. B. Smolders Nov. 1991 57 p Sponsored by Netherlands Technology Foundation
(EUT-91-E-255; ISBN-9-06-144255-9; ETN-93-93159) Avail: CASI HC A04/MF A01

A method for analyzing rectangular microstrip antennas with a dielectric cover, using a spectral domain moment method is presented. The use of this moment method involves the numerical evaluation of slowly decaying Sommerfeld type integrals. Several computational problems are involved with the evaluation of these integrals. Some methods to avoid these problems are discussed. One of the methods developed accelerates the calculation of the infinite integrals over the slowly decaying integrands. This slow convergence is caused by the source singularity in the Green's function of the dielectric slab. To overcome this disadvantage, a method of rewriting the integrals as a sum of a closed form expression and a quickly converging integral was developed. A reduction of computer time by a factor 20 was obtained. This is done for sinusoidal entire domain basis functions on the patch of the microstrip antenna. This method can also be applied for other types of basis functions. ESA

N93-27283*# Virginia Polytechnic Inst. and State Univ., Blacksburg. Satellite Communications Group.
FEASIBILITY STUDY OF A SYNTHESIS PROCEDURE FOR ARRAY FEEDS TO IMPROVE RADIATION PERFORMANCE OF LARGE DISTORTED REFLECTOR ANTENNAS Semiannual Status Report
Warren L. Stutzman, K. Takamizawa, P. Werntz, J. LaPean, and B. Shen Mar. 1993 33 p
(Grant NAG1-859)
(NASA-CR-193030; NAS 1.26:193030; SATCOM-93-3) Avail: CASI HC A03/MF A01

Virginia Tech has several activities which support the NASA Langley effort in the area of large aperture radiometric antenna systems. This semi-annual report discusses the major areas of research and progress made. Derived from text

N93-27403# National Inst. of Standards and Technology, Gaithersburg, MD. Advanced Systems Div.
DARPA TIMIT ACOUSTIC-PHONETIC CONTINOUS SPEECH CORPUS CD-ROM. NIST SPEECH DISC 1-1.1
J. S. Garofolo, L. F. Lamel, W. M. Fisher, J. G. Fiscus, and D. S. Pallett Feb. 1993 85 p See also PB91-505065
(PB93-173938; NISTIR-4930) Avail: CASI HC A05/MF A01

The Texas Instruments/Massachusetts Institute of Technology (TIMIT) corpus of read speech has been designed to provide speech data for the acquisition of acoustic-phonetic knowledge and for the development and evaluation of automatic speech recognition systems. TIMIT contains speech from 630 speakers representing 8 major dialect divisions of American English, each speaking 10 phonetically-rich sentences. The TIMIT corpus includes time-aligned orthographic, phonetic, and word transcriptions, as well as speech waveform data for each spoken sentence. The release of TIMIT contains several improvements over the Prototype CD-ROM released in December, 1988: (1) full 630-speaker corpus, (2) checked and corrected transcriptions, (3) word-alignment transcriptions, (4) NIST SPHERE-headered waveform files and header manipulation software, (5) phonemic dictionary, (6) new test and training subsets balanced for dialectal and phonetic coverage, and (7) more extensive documentation. NTIS

N93-27549# Naval Postgraduate School, Monterey, CA.
ULTRA-WIDEBAND RADAR TRANSIENT DETECTION USING TIME-FREQUENCY AND WAVELET TRANSFORMS M.S. Thesis
William A. Brooks, Jr. Dec. 1992 127 p
(AD-A262154) Avail: CASI HC A07/MF A02

Detection of weak ultra-wideband (UWB) radar signals embedded in non-stationary interference presents a difficult challenge. Classical radar signal processing techniques such as the Fourier transform have been employed with some success. However, time-frequency distributions or wavelet transforms in non-stationary noise appear to present a more promising approach to the detection of transient phenomena. In this thesis, analysis of synthetic signals and UWB radar data is performed using time-frequency techniques, such as the short time Fourier transform (STFT), the Instantaneous Power Spectrum and the Wigner-Ville distribution, and time-scale methods, such as the a trous discrete wavelet transform (DWT) algorithm and Mallat's DWT algorithm. The performance of these methods is compared and the characteristics, advantages, and drawbacks of each technique are discussed. DTIC

N93-27643# Defence Research Establishment, Ottawa (Ontario).
A NEW ANALYSIS OF THE MULTIPATH RADAR DATA MEASURED BY STANDARD TELECOMMUNICATION LABORATORIES
Eric K. Hung, Robert W. Herring, and Janet E. Morris Dec. 1992 31 p
(AD-A261981; DREO-1138) Avail: CASI HC A03/MF A01

A new analysis of some multipath radar data measured with an array antenna and low-flying aircraft is presented. The data were previously analyzed by the singular value decomposition (SVD) method. The researchers were mainly interested in whether or not the SVD method produced elevation estimates consistently close to the true target elevations derived from an adjacent optical tracker. The new analysis, also using the SVD method, has produced additional results. Firstly, it demonstrates a practical technique for selecting target elevation estimates when the target range was less than 6.5 km. Secondly, it provides an explanation, supported with simulations, for the presence of many false tracks branching out from the target and image tracks. DTIC

N93-27668# Naval Postgraduate School, Monterey, CA.
THE DESIGN AND EVALUATION OF TRANSMIT AND RECEIVE ANTENNAS FOR AN IONOSPHERIC COMMUNICATIONS PROBE SYSTEM. A: MULTIBAND DIPOLE ANTENNA M.S. Thesis
Sotirios G. Perros Dec. 1992 120 p
(AD-A262010) Avail: CASI HC A06/MF A02

This thesis reports the design, performance evaluation and construction of a transmitting antenna for an HF communications probe system. A short range-ionospheric communication link between Monterey, CA, (transmit site) and San Diego, CA, (receive site) was established to test the software and hardware of this probe system. The Multiband Dipole Antenna was selected as the more practical antenna for this link, using less real estate and support structure than other alternatives. The antenna was constructed and installed at the NPS beach site where the ground constants were measured accurately. Numerical Electromagnetics Code (NEC) analysis and measurements show that the antenna operates with low input VSWR (less than 1.5), is insensitive to electrical ground characteristics and has excellent radiation patterns for short range ionospheric communication links. Based on the observed signal strengths at San Diego, the antenna appears to be performing very well. DTIC

N93-27670# Naval Postgraduate School, Monterey, CA.
A COMPUTER ANALYSIS OF A CONICAL MONOPOLE FOR USE AT NAVAL HIGH FREQUENCY DIRECTION FINDING RECEIVING SITES, PART 2 M.S. Thesis
Panayiotis P. Lemos Dec. 1992 52 p
(AD-A262098) Avail: CASI HC A04/MF A01

The Naval Security Group (NSG) High Frequency Direction Finding (HFDF) sites use large circularly disposed antenna arrays (CDAA) with moderate to high gain beams. Omnidirectional coverage is presently obtained by combining 8 to 120 elements of the CDAA. Recent measurements of site performance reveal that most HFDF sites suffer from high noise levels. Much of the noise is generated in the RF distribution system. This noise contaminates the CDAA omni signals, greatly reducing their effectiveness. One proposed solution to the problem is to use a semi-remotely located broadband conical monopole (CM), which does not connect through the noisy RF distribution system. A proof-of-performance comparing the CM and CDAA omnis is commencing at NSG. In this thesis, the performance of the model 2012AA Conical Monopole Antenna is studied in the presence of finite ground using the Numerical Electromagnetics Code (NEC-3). Ground constants used in this study were obtained for two locations where the CM are installed; Northwest, VA, and Winter Harbor, ME. The performance of the combined antenna/ground system was simulated over a frequency range from 2 to 30 MHz (HF), for various ground constants, with particular emphasis on the elevation plane radiation patterns. Part 2 contains the thesis abstract and figures only. DTIC

N93-27671# Naval Postgraduate School, Monterey, CA.
A COMPUTER ANALYSIS OF A CONICAL MONOPOLE FOR USE AT NAVAL HIGH FREQUENCY DIRECTION FINDING RECEIVING SITES, PART 1 M.S. Thesis
Panayiotis P. Lemos Dec. 1992 74 p
(AD-A262099) Avail: CASI HC A04/MF A01

The Naval Security Group (NSG) High Frequency Direction Finding (HFD) sites use large circularly disposed antenna arrays (CDAA) with moderate to high gain beams. Omnidirectional coverage is presently obtained by combining 8 to 120 elements of the CDAA. Recent measurements of site performance reveal that most HFDF sites suffer from high noise levels. Much of the noise is generated in the RF distribution system. This noise contaminates the CDAA omni signals, greatly reducing their effectiveness. One proposed solution to the problem is to use a semi-remotely located broadband conical monopole (CM), which does not connect through the noisy RF distribution system. A proof-of-performance comparing the CM and CDAA omnis is commencing at NSG. DTIC

N93-27870# Technische Univ., Delft (Netherlands).
CONTACTLESS MICROWAVE LIFETIME MEASUREMENT Ph.D. Thesis
Toofan Otaredian 1992 218 p
(ETN-93-93595) Avail: CASI HC A10/MF A02

Research carried out to measure the recombination lifetime contactlessly and to investigate the interrelations between the measured lifetime by the microwave method and various physical processes in the semiconductors is presented. The interaction of microwaves and semiconductor samples is addressed. A general model for the bulk recombination process is introduced and an examination on how it differs from the well known model of Shockley-Read and Hall is made. A model for the surface recombination process and the significant influence of the transport effects in it are presented. These effects cause a contribution of surfaces to the total recombination process which may differ by several orders of magnitude than what is predicted by the common models. The lifetime measurement principle is demonstrated with respect to results obtained previously as well as a measurement method capable of distinguishing different processes involved in the total recombination process. Some measurement results are given and how they agree with the theoretical models is discussed. ESA

N93-27904# Nijmegen Univ. (Netherlands). Dept. of Informatics.
DESCRIPTION OF AN ADDER BOARD
L. W. J. Rooijakkers 5 Mar. 1992 30 p
(TR-92-09; ETN-93-93143) Avail: CASI HC A03/MF A01

A way of describing regular interconnection patterns and reasoning about them in a transformational way is illustrated. A specific asynchronous digital signal flow network, called an adder board because it adds numbers, is derived from an abstract specification. The derivation consists of two parts: the specification is refined into a form usable for implementation, and an implementation is derived from general laws about the components used to build the network. The result consists of a number of rows built from adder cells. This description is then flattened to obtain a rectangular network which is then transposed and unflattened into a network consisting of columns of adder cells. General component laws as well as properties of the network are proved. It is also shown that the technique does not introduce feedback loops in the network although the descriptions suggest this. ESA

N93-27910# Defence Research Establishment, Ottawa (Ontario).
A FAST FOURIER TRANSFORM APPROACH TO INTERFERENCE SUPPRESSION IN DIRECT SEQUENCE SPREAD SPECTRUM SIGNALS
Brian Kozminchuk Dec. 1992 52 p
(AD-A263019; DREO-TN-93-2) Avail: CASI HC A04/MF A01

An FFT algorithm is examined with respect to its utility as an interference suppressor in direct sequence spread spectrum communications signals. An FFT approach is especially attractive because of its computational economy. It is this approach which has been implemented on the TMS32OC30 hardware forming part of the Advanced Communications Electronic Support Measures System (ACES) and will be implemented on other high-speed hardware forming parts of that system. The basic problem to be solved is described, followed by a description of the algorithm. The algorithm consists of power spectrum estimation using an FFT-based routine, interpolation of the power spectrum at a set of equally-spaced points different from those calculated by the FFT, and design of an FIR linear phase filter which filters the data, i.e., suppresses the interference. This technique is feasible so long as the bandwidth of the interference during the observation time over which the FFT is calculated is much less than the bandwidth of the spread spectrum signal. An important result from this brief study is that the interpolation algorithm used can have an effect on the performance and reliability of the suppression filter ultimately designed and that for small order filters, the discrete Fourier transform approach may be better. DTIC

N93-28054# Federal Aviation Administration, Atlantic City, NJ. Technical Center.
NEXT GENERATION WEATHER RADAR (NEXRAD) PRINCIPAL USER PROCESSOR (PUP) OPERATIONAL TEST AND EVALUATION (OT&E) OPERATIONAL TEST PLAN
Baxter R. Stretcher Jun. 1993 14 p
(DOT/FAA/CT-TN93/22) Avail: CASI HC A03/MF A01

The purpose of this plan is to describe and detail the procedural approach, method, and responsibilities to be employed in conducting the Operational Test and Evaluation (OT&E) on the Next Generation Weather Radar (NEXRAD) Principal User Processor (PUP) system. The testing of the NEXRAD PUP will determine the operational suitability and effectiveness of the NEXRAD PUP aviation weather products used by the Center Weather Service Unit (CWSU) meteorologists for air traffic control (ATC). Author

N93-28076# Universiteit Twente, Enschede (Netherlands). Dept. of Applied Mathematics.

INFLUENCE OF STOCHASTIC CONTACT RESISTANCE ON COUPLING LOSSES

E. M. J. Niessen and R. M. J. vanDamme Aug. 1992 15 p

(MEMO-1067; ETN-93-93849) Avail: CASI HC A03/MF A01

The influence of stochastic contact resistances on coupling losses is determined. The model consists of two parallel stands making contact with each other at several positions. The parallel resistances in the strands are constant. The interstrand contacts can have stochastic values. As time dependent electromagnetic fields induce currents, heat dissipation arises. The dissipation due to the currents between the strands, defined as coupling losses, is investigated for constant contact resistances as well as for stochastic values. From the analysis, both analytical and numerical, it follows that, for spatially dependent time varying applied magnetic fields, the coupling losses increase when the parallel resistances decrease. Furthermore, it is shown that for smaller contact resistances the relative influence of the stochastic nature of the context resistances in the coupling losses increases. ESA

N93-28126*# National Aeronautics and Space Administration. Pasadena Office, CA.

MULTIPATH NOISE REDUCTION SPREAD SPECTRUM SIGNALS Patent Application

Thomas K. Meehan, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) 17 Mar. 1993 41 p

(Contract NAS7-918)

(NASA-Case-NPO-18970-1-CU; NAS 1.71:NPO-18970-1-CU; US-Patent-Appl-SN-039783) Avail: CASI HC A03/MF A01

The concepts of early-prompt delay tracking, multipath correction of early-prompt delay tracking from correlation shape, and carrier phase multipath correction are addressed. In early-prompt delay tracking, since multipath is always delayed with respect to the direct signals, the system derives phase and pseudorange observables from earlier correlation lags. In multipath correction of early-prompt delay tracking from correlation shape, the system looks for relative variations of amplitude across the code correlation function that do not match the predicted multipath-free code cross-correlation shape. The system then uses deviations from the multipath-free shape to infer the magnitude of multipath, and to generate corrections pseudorange observables. In carrier phase multipath correction, the system looks for variations of phase among plural early and prompt lags. The system uses the measured phase variations, along with the general principle that the multipath errors are larger for later lags, to infer the presence of multipath, and to generate corrections for carrier-phase observables. NASA

N93-28190# Naval Postgraduate School, Monterey, CA.

PERFORMANCE EVALUATION OF UHF FADING SATELLITE CHANNEL BY SIMULATION FOR DIFFERENT MODULATION SCHEMES M.S. Thesis

Betulhan Kahraman Dec. 1992 80 p

(AD-A262091) Avail: CASI HC A05/MF A01

In this report, we discuss the physics of fading and summarize the methods to mitigate its devastating effects for communication channels. We evaluated performance curves of Differentially Encoded Binary Phase Shift Keying (DBPSK), Rate 1/2 Convolutionally Encoded Differential Quadrature Phase Shift Keying (DQPSK), and Minimum Shift Keying (MSK) by simulation for both AWGN and fading channels. Further, we simulated typical transponder components of a UHF satellite system and evaluated their effect for the above modulation structures. Finally, we calculated the carrier-to-noise ratios by using simulation curves to assess link margins for the UHF Follow-On Satellite. DTIC

N93-28224# Texas A&M Univ., College Station. Dept. of Electrical Engineering.

RADIATION, SCATTERING, AND GUIDANCE OF ELECTROMAGNETIC FIELDS BY ARBITRARILY SHAPED STRUCTURES EMBEDDED IN LAYERED MEDIA Final Report

Krzysztof A. Michalski 31 Mar. 1993 164 p

(Contract N00014-90-J-1197)

(AD-A262816) Avail: CASI HC A08/MF A02

An integral equation approach based on the mixed-potential formulation is developed for the analysis of radiation, scattering and guidance of electromagnetic waves by arbitrarily shaped conducting objects in layered uniaxial media. This method is successfully applied to rigorously analyze coax- and waveguide-fed microstrip patch antennas of various shapes, as well as multiconductor transmission lines with conductors of various cross-section profiles, embedded in multilayered media. With the approach developed here, microstrip structures of various, possibly irregular shapes, embedded in multilayered isotropic or uniaxial substrates, may be investigated within one theoretical framework and using the same computer program. DTIC

N93-28238# Massachusetts Inst. of Tech., Cambridge.

FILTERING, STATISTICAL SIGNAL PROCESSING AND VARIATIONAL PROBLEMS Final Report, 15 Jan. 1989 - 14 Oct. 1992

Sanjoy Mitter Feb. 1993 26 p

(Grant AF-AFOSR-0276-89)

(AD-A262276; AFOSR-93-0186TR) Avail: CASI HC A03/MF A01

During the grant period the PI made major contributions in three principal areas: (1) Robust Kalman filtering; (2) Structure determination for X-ray crystallography; and (3) Stochastic recursive algorithms for global optimization. These theoretical advances have wide applications in diverse problems, such as identification of systems using maximum likelihood techniques, filtering in the presence of non-Gaussian observation noise, outlier detection, image analysis, and phase estimation problems. DTIC

N93-28289# Air Force Inst. of Tech., Wright-Patterson AFB, OH. Foreign Aerospace Science and Technology Center.

DETECTION PERFORMANCE OF DIGITAL POLARITY SAMPLED PHASE REVERSAL CODE PULSE COMPRESSORS

Zhu Shaoda and Tu Shude 2 Apr. 1993 11 p Transl. into ENGLISH from Dianzikexue Xuekan (China), v. 9, no. 3, May 1987 p 269-272

(AD-A262930; FASTC-ID(RS)T-0309-92) Avail: CASI HC A03/MF A01

The nonparametric constant false alarm rate (CFAR) property of digital polarity sampled phase reversal coded pulse compressors is described. The detection performance in Gaussian and nonGaussian noise is determined. It is shown that the loss in signal-to-noise ratio of the processor, relative to the incoherent matched filter, decreases as the code length increases. The asymptotic loss in Gaussian noise is 1.96dB, and the loss in Weibull noise decreases with the shape parameter of the Weibull distribution and can even become a gain. DTIC

N93-28393# Columbia Univ., New York, NY. Radiation Lab.

RESEARCH INVESTIGATION DIRECTED TOWARD EXTENDING THE USEFUL RANGE OF THE ELECTROMAGNETIC SPECTRUM Annual Progress Report No. 42, 1 Oct. 1991 - 30 Sep. 1992

M. Teich, I. Herman, R. Osgood, Jr., G. Flynn, and E. Yang 31 Dec. 1992 112 p

(Contract DAAL03-91-C-0016)

(AD-A262704) Avail: CASI HC A06/MF A02

We have made two important discoveries regarding the photon statistics in telecommunications devices. In the first, we have shown that the channel capacity of optical receivers in which photon arrival times are observed cannot be improved by modifying an initially Poisson photon stream and making it sub-Poisson. For photon-counting receivers, however, channel capacity enhancement is possible. In the second, we have evaluated system performance in the case of a cascade of fiber amplifiers. We have found that the photon-number distribution at the output of a cascade of erbium-doped fiber amplifiers, with coherent light at the input, turns out to be the noncentral-negative-binomial distribution, even in the presence of intervening loss. We have made significant advances in the investigation of the fundamental optical properties of semiconductors. For example, two relatively simple fractal renewal processes provide a framework for understanding charge transport in amorphous semiconductors; they give rise to spectral power densities with 1/f-like behavior. A new approach for enhancing exciton absorption and increasing the saturation limit in quantum wells, using tensile strain, is suggested; the method relies on valence-band mixing in a strained quantum well. The Auger recombination lifetime in a HgCdTe quantum wire is calculated to be shorter than that in a quantum well, but far shorter than that in quantum box. Consequently, it seems that improved temperature performance can be expected from long-wavelength quantum-box lasers but not from quantum-wire lasers. DTIC

N93-28420# Pacific Northwest Lab., Richland, WA.
ELF ELECTRIC AND MAGNETIC FIELDS: PACIFIC NORTHWEST LABORATORY STUDIES
L. E. Anderson Jun. 1992 14 p Presented at the Annual Meeting of the Air and Waste Management Association (AWMA), Kansas City, MO, 21-26 Jun. 1992
(Contract DE-AC06-76RL-01830)
(DE93-008255; PNL-SA-20993; CONF-9206114-20) Avail: CASI HC A03/MF A01

Studies were conducted at Battelle, Pacific Northwest Laboratory, to examine extremely-low-frequency (ELF) electromagnetic fields for possible biological effects in animals. Three areas of investigation are reported here: (1) studies on the nervous system, including behavior and neuroendocrine function; (2) experiments on cancer development in animals; and (3) measurements of currents and electric fields induced in animal models by exposure to external magnetic fields. In behavioral experiments, rats were shown to be responsive to ELF electric field exposure. Furthermore, experimental data indicate that short-term memory may be affected in albino rats exposed to combined ELF and static magnetic fields. Neuroendocrine studies were conducted to demonstrate an apparent stress-related response in rats exposed to 60-Hz electric fields. Nighttime pineal melatonin levels were shown to be significantly depressed in animals exposed to either electric or magnetic fields. A number of animal tumor models are currently under investigation to examine possible relationships between ELF exposure and carcinogenesis. Finally, theoretical and experimental measurements were performed which form the basis for animals and human exposure comparisons. DOE

N93-28422*# National Aeronautics and Space Administration. Pasadena Office, CA.
PARALLEL AND SERIES FED MICROSTRIP ARRAY WITH HIGH EFFICIENCY AND LOW CROSS POLARIZATION Patent Application
John Huang, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) 28 Apr. 1993 17 p
(Contract NAS7-918)
(NASA-Case-NPO-18678-1-CU; NAS 1.71:NPO-18678-1-CU; US-Patent-Appl-SN-056018) Avail: CASI HC A03/MF A01

A microstrip array antenna for vertically polarized fan beam (approximately 2 deg x 50 deg) for C-band SAR applications with a physical area of 1.7 m by 0.17 m comprises two rows of patch elements and employs a parallel feed to left- and right-half sections of the rows is described. Each section is divided into two segments that are fed in parallel with the elements in each segment fed in series through matched transmission lines for high efficiency. The inboard section has half the number of patch elements of the outboard section, and the outboard sections, which have tapered distribution with identical transmission line sections, terminated with half wavelength long open-circuit stubs so that the remaining energy is reflected and radiated in phase. The elements of the two inboard segments of the two left- and right-half sections are provided with tapered transmission lines from element to element for uniform power distribution over the central third of the entire array antenna. The two rows of array elements are excited at opposite patch feed locations with opposite (180 deg difference) phases for reduced polarization. NASA

N93-27727*# Millitech Corp., South Deerfield, MA.
COHERENT SYSTEMS IN THE TERAHERTZ FREQUENCY RANGE: ELEMENTS, OPERATION, AND EXAMPLES
Paul F. Goldsmith *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 1-23 Prepared in cooperation with Five-College Astronomy Dept., Amherst, MA (For primary document see N93-27726 10-31)
Avail: CASI HC A03/MF A06

N93-27728*# California Univ., Santa Barbara. Dept. of Electrical and Computer Engineering.
BROADBAND MILLIMETER-WAVE GaAs TRANSMITTERS AND RECEIVERS USING PLANAR BOW-TIE ANTENNAS
Y. Konishi (Shimadzu Corp., Kyoto, Japan.), M. Kamegawa (Shimadzu Corp., Kyoto, Japan.), M. Case, R. Yu, M. J. W. Rodwell, R. A. York, and D. B. Rutledge (California Inst. of Tech., Pasadena.) *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 24-31 (For primary document see N93-27726 10-31)
(Grant AF-AFOSR-0394-89)
Avail: CASI HC A02/MF A06

N93-27729*# Michigan Univ., Ann Arbor. NASA Center for Space Terahertz Technology.
ACTIVE CPW-FED SLOT ANTENNAS FOR POWER COMBINING APPLICATIONS
Brian K. Kormanyos and Gabriel M. Rebeiz *In its* The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 32-36 Sponsored in part by RADC (For primary document see N93-27726 10-31)
Avail: CASI HC A01/MF A06

N93-27745*# California Inst. of Tech., Pasadena. Physics Lab.
SLOT ANTENNA SIS MIXERS FOR SUBMILLIMETER WAVELENGTHS Abstract Only
Jonas Zmuidzinas, Henry G. LeDuc (Jet Propulsion Lab., California Inst. of Tech., Pasadena.), and J. A. Stern (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 234 (For primary document see N93-27726 10-31)
Avail: CASI HC A01/MF A06

N93-27751*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
SLOT-LINE END-FIRE ANTENNAS FOR THz FREQUENCIES
H. Ekstroem (Chalmers Univ. of Technology, Goeteborg, Sweden.), S. Gearhart (Michigan Univ., Ann Arbor.), P. R. Acharya (Chalmers Univ. of Technology, Goeteborg, Sweden.), H. Dave, G. Rebeiz (Michigan Univ., Ann Arbor.), S. Jacobsson (Chalmers Univ. of Technology, Goeteborg, Sweden.), E. Kollberg (Chalmers Univ. of Technology, Goeteborg, Sweden.), and G. Chin *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 280-290 (For primary document see N93-27726 10-31)
Avail: CASI HC A03/MF A06

N93-27753*# Michigan Univ., Ann Arbor. NASA Center for Space Terahertz Technology.
ANALYSIS OF A NOVEL NON-CONTACTING WAVEGUIDE BACKSHORT
T. M. Weller, L. P. B. Katehi, and William R. McGrath (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) *In its* The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 298-315 (For primary document see N93-27726 10-31)
Avail: CASI HC A03/MF A06

N93-27754*# California Inst. of Tech., Pasadena. Dept. of Electrical Engineering.
SILICON MICROMACHINED WAVEGUIDES FOR MILLIMETER AND SUBMILLIMETER WAVELENGTHS
Markus Yap, Yu-Chong Tai, William R. McGrath (Jet Propulsion Lab., California Inst. of Tech., Pasadena.), and Christopher Walker (Arizona Univ., Tucson.) *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 316-323 Sponsored in part by Strategic Defense Initiative Organization (For primary document see N93-27726 10-31)
(Contract PF-347)
Avail: CASI HC A02/MF A06

N93-27755*# Michigan Univ., Ann Arbor. NASA Center for Space Terahertz Technology.
PROGRESS IN INTEGRATED-CIRCUIT HORN ANTENNAS FOR RECEIVER APPLICATIONS. PART 1: ANTENNA DESIGN
George V. Eleftheriades, Walid Y. Ali-Ahmad, and Gabriel M. Rebeiz *In its* The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 324-337 Submitted for publication (For primary document see N93-27726 10-31)
Avail: CASI HC A03/MF A06

N93-27756*# Michigan Univ., Ann Arbor. NASA Center for Space Terahertz Technology.
PROGRESS IN INTEGRATED-CIRCUIT HORN ANTENNAS FOR RECEIVER APPLICATIONS. PART 2: A 90 GHz QUASI-INTEGRATED HORN ANTENNA RECEIVER
Walid Y. Ali-Ahmad, George V. Eleftheriades, and Gabriel M. Rebeiz *In its* The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 338-344 (For primary document see N93-27726 10-31)
Avail: CASI HC A02/MF A06

N93-27757*# Five-College Astronomy Dept., Amherst, MA.
ZONE PLATE LENS ANTENNAS FOR MILLIMETER AND SUBMILLIMETER WAVELENGTHS
Paul F. Goldsmith *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 345-361 Prepared in cooperation with Millitech Corp., South Deerfield, MA (For primary document see N93-27726 10-31)
Avail: CASI HC A03/MF A06

N93-27759*# Michigan Univ., Ann Arbor. NASA Center for Space Terahertz Technology.
DOUBLE-SLOT ANTENNAS ON EXTENDED HEMISPHERICAL DIELECTRIC LENSES
Daniel F. Filipovic, Steve J. Gearhart, Brian K. Kormanyos, and Gabriel M. Rebeiz *In its* The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 382-393 (For primary document see N93-27726 10-31)
Avail: CASI HC A03/MF A06

N93-27782*# California Univ., Berkeley. Dept. of Physics.
A BROADBAND THz RECEIVER FOR LOW BACKGROUND SPACE APPLICATIONS
C. Hagmann, D. J. Benford, A. C. Clapp, P. L. Richards, and P. Timbie *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 678-687 (For primary document see N93-27726 10-31)
(Contract NsG-7205; NAGw-2121; JPL-958764; NSF AST-88-09616)
Avail: CASI HC A02/MF A06

N93-27983*# General Communication, Inc., Anchorage, AK.
CONSIDERATIONS FOR LUNAR COLONY COMMUNICATIONS SYSTEMS
Richard P. Dowling *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 7 p (For primary document see N93-27956 10-91)
Avail: CASI HC A02/MF A03

33 ELECTRONICS AND ELECTRICAL ENGINEERING

Includes test equipment and maintainability; components, e.g., tunnel diodes and transistors; microminiaturization; and integrated circuitry.

For related information see also *60 Computer Operations and Hardware* and *76 Solid-State Physics.*

N93-26612# California Univ., Berkeley. Lawrence Berkeley Lab.
USING COHERENT ILLUMINATION TO EXTEND HRTEM RESOLUTION: WHY WE NEED A FEG-TEM FOR HREM
M. A. OKeefe Nov. 1992 9 p Presented at the Microstructures of Materials Conference, Berkeley, CA, 22-23 Oct. 1992
(Contract DE-AC03-76SF-00098)
(DE93-007724; LBL-33157; CONF-9210311-2) Avail: CASI HC A02/MF A01

Resolution of a high-resolution transmission electron microscope (HRTEM) has traditionally been defined in terms of its Scherzer resolution limit at optimum defocus. However, even beyond the Scherzer limit, spatial frequencies can be transferred from the specimen to the image, out to the so-called information limit of the electron microscope. The information limit of the HRTEM is determined by the degree of energy spread in the electron beam used to illuminate the sample. Since a HRTEM equipped with a field-emission gun (FEG) will produce an electron beam of high coherence with little energy spread, it can achieve an improved information-limit, and can thus be used to produce through-focus series of images containing information well beyond its nominal (Scherzer) resolution limit. Suitable computer processing of such series of images can produce composite images at resolutions approaching the microscope information limit. For such a FEG-TEM, combined with suitable computer image processing, resolution can approach 1 A. DOE

N93-26701*# Georgia Inst. of Tech., Atlanta. School of Electrical Engineering
AN ACOUSTIC CHARGE TRANSPORT IMAGER FOR HIGH DEFINITION TELEVISION APPLICATIONS
William D. Hunt, Kevin F. Brennan, and Christopher J. Summers (Georgia Inst. for Research, Atlanta.) May 1993 94 p
(Grant NAGw-2753)
(NASA-CR-193081; NAS 1.26:193081; E21-687; E21-H83) Avail: CASI HC A05/MF A01

The progress during the third six month period of the project is presented. This includes both experimental and theoretical work on the acoustic charge transport (ACT) portion of the chip, the theoretical program modeling of the avalanche photodiode (APD) and the charge overflow transistor, and the materials growth and fabrication part of the program. Among other results from a comprehensive experimental study, it was found that the use of a ZnO thin film piezoelectric overlay can reduce the RF power consumption of a typical ACT device from 28 dBm to 8 dBm. Author (revised)

N93-27002*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
DIFFUSION LENGTH VARIATION IN 0.5- AND 3-MeV-PROTON-IRRADIATED, HETEROEPITAXIAL INDIUM PHOSPHIDE SOLAR CELLS
Raj K. Jain (National Academy of Sciences - National Research Council, Washington, DC.), Irving Weinberg, and Dennis J. Flood Apr. 1993 7 p Presented at the Fifth International Conference on Indium Phosphide and Related Materials, Paris, France, 18-22 Apr. 1993; cosponsored by IEEE Lasers and Electro-Optics Society and IEEE Electron Devices Society
(RTOP 506-41-11)
(NASA-TM-106147; E-7792; NAS 1.15:106147) Avail: CASI HC A02/MF A01

Indium phosphide (InP) solar cells are more radiation resistant than gallium arsenide (GaAs) and silicon (Si) solar cells, and their growth by heteroepitaxy offers additional advantages leading to the development of light weight, mechanically strong, and cost-effective cells. Changes in heteroepitaxial InP cell efficiency under 0.5- and 3-MeV proton irradiations have been explained by the variation in the minority-carrier diffusion length. The base diffusion length versus proton fluence was calculated by simulating the cell performance. The diffusion length damage coefficient, K(sub L), was also plotted as a function of proton fluence. Author (revised)

N93-27099# Cortest Columbus Technologies, OH.
ALTERNATING CURRENT (AC) IMPEDANCE TESTING OF COATED TRAYCANS Final Report, Jul. 1991 - Jan. 1993
Kurt Lawson and John Beavers Jan. 1993 32 p
(Contract DAAK60-90-C-1301; DA Proj. 728-01219)
(AD-A261256; NATICK-TR-93-019) Avail: CASI HC A03/MF A01

The overall objective of the program was to evaluate the relative resistance of several candidate coatings prior to retorting to a solution containing NaCl and citric acid (simulating saline, acidic food product) at ambient temperature. An additional objective of the program was to perform an initial assessment of the applicability of the AC impedance technique as a quality assurance technique for traycan coatings. The performance of the coatings was evaluated by means of an Electrochemical Impedance Spectroscopy (EIS) technique, also referred to as AC impedance. The EIS technique was found to be a sensitive technique for measuring coating degradation on the traycans. Of the coatings analyzed, the VMC coating, in general was found to be the best performer, followed closely by DMS and VMS. The control coating was found to be the poorest coating, of the coatings analyzed. DTIC

N93-27265*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

MICROWAVE CHARACTERIZATION OF SLOTLINE ON HIGH RESISTIVITY SILICON FOR ANTENNA FEED NETWORK

Rainee N. Simons (Sverdrup Technology, Inc., Brook Park, OH.), Susan R. Taub, Richard Q. Lee, and Paul G. Young (Toledo Univ., OH.) Mar. 1993 9 p Proposed for presentation at the 1992 IEEE AP-S International Symposium and URSI Radio Science Meeting, Ann Arbor, MI, 27 Jun. - 2 Jul. 1993; sponsored by IEEE and USNC Commissions A,B,D, and F

(RTOP 506-44-2C)

(NASA-TM-106058; E-7659; NAS 1.15:106058) Avail: CASI HC A02/MF A01

Conventional silicon wafers have low resistivity and consequently unacceptably high value of dielectric attenuation constant. Microwave circuits for phased array antenna systems fabricated on these wafers therefore have low efficiency. By choosing a silicon substrate with sufficiently high resistivity it is possible to make the dielectric attenuation constant of the interconnecting microwave transmission lines approach those of GaAs or InP. In order for this to be possible, the transmission lines must be characterized. In this presentation, the effective dielectric constant (epsilon sub eff) and attenuation constant (alpha) of a slotline on high resistivity (5000 to 10 000 ohm-cm) silicon wafer will be discussed. The epsilon sub eff and alpha are determined from the measured resonant frequencies and the corresponding insertion loss of a slotline ring resonator. The results for slotline will be compared with microstrip line and coplanar waveguide. Author (revised)

N93-27367# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Numerical Mathematics.

INCOMPLETE LINE LU FOR DISCRETIZED COUPLED PDE'S AS PRECONDITIONER IN Bi-CGSTAB

P. M. deZeeuw Jul. 1992 44 p

(CWI-NM-R9213; ETN-93-93267) Copyright Avail: CASI HC A03/MF A01

A variant of the recently developed Bi-CGSTAB method is applied to solving the linear systems that typically occur when applying Newton's method to a discretized set of coupled elliptic Partial Differential Equations (PDE) in two dimensions. Bi-CGSTAB is a reformulation of the Induced Dimension Reduction (IDR) method and cures the irregular convergence behavior of the Conjugate Gradient-Squared (CG-S) method. The Incomplete Line LU relaxation is generalized for the case of coupled equations and applied as preconditioner. Both an eligible stopping and restart criterion are developed for the Bi-CGSTAB method. Numerical experiments are performed for problems stemming from the area of semiconductor modeling and an aquifer problem. For the latter problem a comparison is made with an existing multigrid algorithm in which Incomplete Line LU relaxation is used as a smoothing procedure. ESA

N93-27645# Purdue Univ., West Lafayette, IN. School of Electrical Engineering.

INVESTIGATION OF A NEW CONCEPT IN SEMICONDUCTOR MICROWAVE OSCILLATORS: THE CONTIGUOUS DOMAIN OSCILLATOR Final Report, 1 Jul. 1991 - 31 Dec. 1993

James A. Cooper, Jr. 28 Feb. 1993 139 p

(Grant AF-AFOSR-0224-91)

(AD-A262352; AFOSR-93-0192TR) Avail: CASI HC A07/MF A02

The objective of the research was to produce new devices having lower gate resistance and to demonstrate contiguous-domain operation. These new devices were to be built and delivered by mid-1991. Due to a series of problems, the devices were never delivered. Instead, we have shifted our emphasis to computer simulation, and have developed a new computer model of the devices which shows the transition from multiple to single-domain mode as the gate is moved further away from the channel. This new simulation program allows us to study the transition regime and to investigate the range of device parameters over which contiguous-domain mode operation can be expected. DTIC

N93-27673# Naval Surface Warfare Center, Dahlgren, VA.

HIGH-VOLTAGE PULSE GENERATOR CAPABLE OF 200 J AT 5 kV Final Report

Harry E. Cleaver 31 Jul. 1992 52 p

(AD-A262111; NSWCDD/MP-92/224) Avail: CASI HC A04/MF A01

The 5-kV High-Voltage Pulse Generator is used to deliver high-energy pulses to initiating devices for explosive tests. While the triggered spark gap installed has a 200-J rating, the energy storage capacitor used limits the output to 57.6 J at 4.8 kV. At this limit, the pulser delivers a peak current of 2400 A into a 1.25-Q resistive load. DTIC

N93-27871# Technische Univ., Delft (Netherlands).

QUANTUM TRANSPORT OF ELECTRONS IN NANOSTRUCTURED SILICON MOSFET'S Ph.D. Thesis

Carolien deGraaf 1992 136 p Sponsored by Stichting voor Fundamenteel Onderzoek der Materie, Netherlands

(ETN-93-93597) Avail: CASI HC A07/MF A02

An experimental study of electron transport in nanostructured silicon MOSFETS's (Metal Oxide Semiconductor Field Effect Transistors) having a point contact or lateral superlattice geometry is presented. Theoretical aspects of mesoscopic electron transport are described and the following are reported: dual gate nanostructured Si-MOSFET's (fabrication and characterization); weak localization in short one dimensional channels contacted by two dimensional probes; conductance quantization in Si-MOSFET point contacts; variable range hopping via a small number of localized states in nanometer scale MOSFET's; Coulomb blockade oscillations in the conductance of a silicon MOSFET point contact; and modification of weak localization in a lateral superlattice. A fabrication process for dual gate nanostructured Si-MOSFET's is outlined. ESA

N93-27880# Technische Univ., Delft (Netherlands).

TRANSPORT OF ELECTRON-WAVES AND SINGLE-CHARGES IN SEMICONDUCTOR NANOSTRUCTURES Ph.D. Thesis

Leonardus Petrus Kouwenhoven 1992 180 p Sponsored by Stichting voor Fundamenteel Onderzoek der Materie, Netherlands

(ETN-93-93609) Avail: CASI HC A09/MF A02

A number of experiments performed in submicron semiconductor structures are described. The submicron structures are defined in the two Dimensional Electron Gas (2DEG) of a GaAs/AlGaAs heterostructure by means of metallic gates which are fabricated on top of the heterostructure. Applying negative voltages to the gates depletes the electron gas beneath them, leaving free electrons only in the ungated regions. A split gate geometry with an opening and a length of a few 100 nm induces a channel in the 2DEG, which is short and narrow compared to the elastic mean free path in the 2DEG. The transport through such a constriction is, therefore, ballistic. The Fermi wave length of the electrons is about 50 nm and, therefore, is also of the order of the constriction width, so the electron wave nature affects the transport properties. The quantum ballistic transport regime in these submicron devices is addressed and charging effects in semiconductor quantum dots are discussed. ESA

N93-27911# Defence Research Establishment, Ottawa (Ontario).

AN IMPROVED KALMAN FILTER EXCISOR FOR SUPPRESSING NARROWBAND GAUSSIAN NOISE INTERFERENCE

Brian Kozminchuk Nov. 1992 36 p

(AD-A263020; DREO-92-28) Avail: CASI HC A03/MF A01

This technical note presents an improved Kalman filter excisor for dealing with narrowband Gaussian noise. For this type of interference, both envelope and phase vary with time. Since the Kalman filter approach is close to optimum for interferers with constant or very slowly varying envelopes, performance for the narrowband Gaussian noise case will be significantly less than optimum. Ways and means of improving the performance by up to 5 dB are presented. These include the use of an alternate filtering approach to estimate the envelope to counter group delay effects, and phase-smoothing to suppress some of the additional noise caused by temporary loss of lock by the Kalman filter during those instants when the envelope changes sign. DTIC

N93-27918# Stanford Univ., CA. Solid-State Electronics Lab.

JSEP ANNUAL REPORT, 11 JANUARY 1991 - 10 JANUARY 1993

James S. Harris, Jr. Mar. 1993 102 p

(Contract DAAL03-91-C-0010)

(AD-A261948; ARO-28326.9-EL) Avail: CASI HC A06/MF A02

This is the annual report of the research conducted at the Stanford Electronics Laboratories under the sponsorship of the Joint Services Electronics Program from 11 January 1992 through 10 January 1993. This

report summarizes the area of research, identifies the most significant results and lists the dissertations and publications sponsored by the contract DAAL03-91-C-0010. DTIC

N93-27919# Science Applications International Corp., McLean, VA.
DARPA ADVANCED HIGH CURRENT DENSITY CATHODES FOR DEFENSE APPLICATIONS: DEVELOPMENT PHASE Final Report
1 Mar. 1993 336 p
(Contract N00014-90-C-2118)
(AD-A261949; SAIC-93/1018) Avail: CASI HC A15/MF A03

Topics include: Design and Analysis of Advanced Microstructure Cathodes; Fabrication of Eutectic Composite Cathodes; Testing of Tubule Microstructure Cathodes and Eutectic Composite Cathodes; and Applications Evaluation. DTIC

N93-27941# Technische Univ., Delft (Netherlands). Micro Engineering Lab.
DEVELOPMENT OF CAPACITIVE POSITION TRANSDUCERS THROUGH A MECHATRONIC APPROACH Ph.D. Thesis
Fang Zhu 1992 202 p
(Contract IOP-IC-DTN-48-020)
(ISBN-90-9005114-7; ETN-93-93621) Avail: CASI HC A10/MF A03

Research to fundamentally study capacitive position transducers following a 'mechatronical' approach is presented. Theoretical and experimental investigations lead to some significant results. The investigations were based on the fundamental theory of physics related to the capacitive transducer, electronic circuitry for capacitance measurement and the available methods of precision engineering. In view of these fundamental studies, three new types of capacitive position transducers were developed. Conclusions drawn from this broad research are detailed. ESA

N93-28150# Sandia National Labs., Albuquerque, NM.
LONG LIFETIME SILICON PHOTOCONDUCTIVE SEMICONDUCTOR SWITCHES
G. M. Loubriel, F. J. Zutavern, G. J. Denison, W. D. Helgeson, D. L. McLaughlin, M. W. OMalley, C. H. Sifford, L. C. Beavis, C. H. Seager, and A. Rosen (David Sarnoff Research Center, Princeton, NJ.) 1992 12 p Presented at the International Society for Optical Engineering (SPIE) Conference, Los Angeles, CA, 16-23 Jan. 1993
(Contract DE-AC04-76DP-00789)
(DE93-006757; SAND-92-1202C; CONF-930159-13) Avail: CASI HC A03/MF A01

We present the results of experiments aimed at improving the lifetime (longevity) of Si photoconductive semiconductor switches (PCSS). Because damage at the metal-semiconductor interface is the primary damage mechanism in most PCSS's, we have tested different contact metallizations. The test setup utilizes the following: a ND:YAG laser that operates at 540 Hz with 50 NJ, 10 ns FWHM pulses; a circuit that charges a 50 ohm line in 800 ns and discharges it in 20 ns through a 50 ohm load; and a lateral switch geometry and 0.25 cm by 0.25 cm switches. The contacts examined include the following: Cr(diffused)-Cr-Mo-Au, Al(diffused)-Cr-Mo-Au, P-31(ion implanted)-Ti-Pt, Al(diffused)Pt-Ti-Pd-Au, and edge contacts. In the case of the Cr contacts we have tried thicker Mo or Au layers. For the Al contacts we have tried 1 and 0.1 micron thick depositions. Most contacts survived 10(exp 7) pulses when switching 32 kv/cm (8 kV over 0.25 cm). The Al diffused went up to 44 kv/cm (1 x 10(exp 5) pulses). The implanted P switch was switched 2.2 x 10(exp 7) times at 44 kv/cm and 0.9 x 10(exp 6) times at 48 kv/cm. DOE

N93-28188# Naval Postgraduate School, Monterey, CA.
VISIBLE SPECTRUM OF STABLE SONOLUMINESCENCE M.S. Thesis
Joseph T. Carlson Dec. 1992 108 p
(AD-A262096) Avail: CASI HC A06/MF A02

Synchronous emissions of picosecond pulses of light are observed to originate from a bubble trapped at the pressure antinode of a resonant sound field. The spectrum has been measured using a single slit spectrometer equipped with a linear array CCD detector. Spectra from differing solutions of water and glycerin are compared to the visible blackbody spectrum distribution. Assuming a blackbody model, apparent temperatures of 18,900 Kelvins are observed in pure water. Increasing glycerin concentration appears to correlate with cooler blackbody temperatures. The spectrum is also found to continually change with time, independent of input parameters. DTIC

N93-28217# City Coll. of the City Univ. of New York, NY. Dept. of Physics.
MAGNETIC PROPERTIES AND CRITICAL BEHAVIOR OF THE CONDUCTIVITY NEAR THE M-I TRANSITION
M. Sarachik Apr. 1993 10 p
(Contract DE-FG02-84ER-45153)
(DE93-011437; DOE/ER-45153/10) Avail: CASI HC A02/MF A01

Results of studies of resistivity, magnetoresistance, and Hall coefficient of Si:B are reported. Experiments in the insulating phase (hopping conduction) were done on various materials (in-type CdSe, doped Si, GaAs, etc.). DOE

N93-28327*# Akron Univ., OH. Dept. of Electrical Engineering.
STUDY OF SWITCHING TRANSIENTS IN HIGH FREQUENCY CONVERTERS Final Report
Donald S. Zinger, Malik E. Elbuluk, and Tony Lee 3 Jun. 1993 140 p
(Grant NAG3-1236)
(NASA-CR-193105; NAS 1.26:193105) Avail: CASI HC A07/MF A02

As the semiconductor technologies progress rapidly, the power densities and switching frequencies of many power devices are improved. With the existing technology, high frequency power systems become possible. Use of such a system is advantageous in many aspects. A high frequency ac source is used as the direct input to an ac/ac pulse-density-modulation (PDM) converter. This converter is a new concept which employs zero voltage switching techniques. However, the development of this converter is still in its infancy stage. There are problems associated with this converter such as a high on-voltage drop, switching transients, and zero-crossing detecting. Considering these problems, the switching speed and power handling capabilities of the MOS-Controlled Thyristor (MCT) makes the device the most promising candidate for this application. A complete insight of component considerations for building an ac/ac PDM converter for a high frequency power system is addressed. A power device review is first presented. The ac/ac PDM converter requires switches that can conduct bi-directional current and block bi-directional voltage. These bi-directional switches can be constructed using existing power devices. Different bi-directional switches for the converter are investigated. Detailed experimental studies of the characteristics of the MCT under hard switching and zero-voltage switching are also presented. One disadvantage of an ac/ac converter is that turn-on and turn-off of the switches has to be completed instantaneously when the ac source is at zero voltage. Otherwise shoot-through current or voltage spikes can occur which can be hazardous to the devices. In order for the devices to switch softly in the safe operating area even under non-ideal cases, a unique snubber circuit is used in each bi-directional switch. Detailed theory and experimental results for circuits using these snubbers are presented. A current regulated ac/ac PDM converter built using MCT's and IGBT's is evaluated. Author (revised)

N93-28329# Brookhaven National Lab., Upton, NY.
MICROSTRUCTURAL FACTORS INFLUENCING CRITICAL-CURRENT DENSITIES OF HIGH-TEMPERATURE SUPERCONDUCTORS
M. Suenaga 1992 6 p Presented at the 5th United States/Japan Workshop on High Tc Superconductors, Tsukuba, Japan, 9-10 Nov. 1992
(Contract DE-AC02-76CH-00016)
(DE93-006651; BNL-48199; CONF-9211144-6) Avail: CASI HC A02/MF A01

Microstructural defects are the primary determining factors for the values of critical current densities in superconductors. A review is made to assess (1) what would be the maximum achievable critical-current density in the oxide superconductors if nearly ideal pinning sites were introduced?, and (2) what types of pinning defects are currently introduced in these superconductors and how effective are these in pinning the vortices? Only the case where the applied field is parallel tc the c-axis is considered here. DOE

N93-28344# Argonne National Lab., IL.
MAGNETIC PROPERTIES AND IRREVERSIBILITY BEHAVIOR IN Ag-SHEATHED Bi-BASED SUPERCONDUCTING WIRES FABRICATED USING A CONTROLLED MELT PROCEDURE
S. X. Dou (New South Wales Univ., Kensington, Australia.), H. K. Liu (New

South Wales Univ., Kensington, Australia.), Y. C. Guo (New South Wales Univ., Kensington, Australia.), D. L. Shi, M. D. Sumption (Battelle Memorial Inst., Argonne, IL.), and E. W. Collings (Battelle Memorial Inst., Argonne, IL.) Dec. 1992 8 p Presented at the 5th International Symposium on Superconductivity, Kobe, Japan, 16-19 Nov. 1992
(Contract W-31-109-eng-38)
(DE93-005554; ANL/MSD/CP-78464; CONF-921124-2) Avail: CASI HC A02/MF A01

A significant enhancement of the in-field J(sub c) of Ag-clad (Bi,Pb)-Sr-Ca-Cu-0 (BPSCCO:2223) wires has been achieved using a controlled melt procedure. The greatly reduced weak linking has resulted in an extended plateau regime in the J(sub c)-H curve. J(sub c)'s of 40,000 A/sq cm at 77 K (self field) and 9,000 A/sq cm at 77 K (1 T) have been achieved. The improved J(sub c)-H characteristics may be attributed to microstructures consisting of uniform grain alignment throughout the entire cross section, intimate connection between grains, impurities within the grains, and an optimal level of dispersed 2212 phase. Irreversibility line measurements using both AC susceptibility in DC fields (reported elsewhere), and magnetization measurements, have indicated that flux pinning can be enhanced in the melt-processed samples over the results of normal solid-state processing with its less-than optimal 2212-phase content. But sufficiently long annealing times during the 'normal' route may achieve 2212-phase content and J(sub c)'s which are comparable to those of melt-processed samples. DOE

N93-28381# Georgia Tech Research Inst., Atlanta.
FABRICATION TECHNIQUES AND TECHNOLOGIES FOR MISSILE SEEKER MICROELECTRONIC COMPONENTS (FOCUSING ON MULTI-CHIP MODULE SUBSTRATE RELIABILITY) Final Technical Report, 15 Jul. 1991 - 30 Sep. 1992
B. R. Livesay, R. A. Bohlander, L. J. Turbini, and J. B. Schodorf Nov. 1992 93 p
(Contract DAAH01-89-D-0133)
(AD-A262809; AD-E951952; A9017; AMSMI-TR-CR-RD-SR-93-1) Avail: CASI HC A05/MF A01

This report reviews recent multi-chip module (MCM) manufacturing technology developments. MCM's represent an emerging technology which will provide the Army with high-speed processors for missile seekers in a more compact form than offered by previous generations of electronic packaging. Both ceramic (MCM-C) and deposited dielectric (MCM-D) forms are covered, including those incorporating polyimide and new polymer films. Recent literature is reviewed concerning recent manufacturing processes, necessary generic equipment under development and in current practice. Promising developments include low-temperature cofired ceramics, polymer dielectrics with low water absorptivity, new photo-definable polymers, new adhesion promoters, gold thin-film metallization methods, laser ablation of vias, and controlled polymer precursors extrusion. Reliability issues are emphasized in the review, particularly in respect of the severe environmental conditions experienced by missiles, and a detailed review of mechanisms of degradation is included. Recommendations are made on the need for micromechanical and electrical property measurements of candidate MCM materials. DTIC

N93-28458# Sandia National Labs., Albuquerque, NM.
DIAMOND: A NEW HIGH THERMAL CONDUCTIVITY SUBSTRATE FOR MULTICHIP MODULES AND HYBRID CIRCUITS
D. Norwood, W. Worobey, D. Peterson, and D. Miller 1992 11 p Presented at the 43rd Electronic Component and Technology Conference, Orlando, FL, 1-3 Jun. 1993
(Contract DE-AC04-76DP-00789)
(DE93-008337; SAND-92-2476C; CONF-9306104-2) Avail: CASI HC A03/MF A01

As applications for hybrid circuits and multichip modules create demand for higher density circuits and higher power components, new substrate materials are required to deal with the heat generated on the circuit. Sandia National Laboratories is developing diamond substrate technology to meet the requirements of high thermal conductivity. Thin film processes were developed and characterized to delineate conductor-resistor networks on free standing diamond substrates having fine line gold conductors and low and high sheet resistivity resistors. Thin film hybrid circuit technology was developed on CVD-processed, polycrystalline diamond substrates having as-deposited surface finishes as well as those with polished surfaces. Conductors were defined by pattern plating gold and resistors were processed from sputtered tantalum nitride films which were deposited to sheet resistivities of 5 and/or 100 ohms per square. Resistor films on diamond substrates were evaluated for Temperature Coefficient of Resistance (TCR), stability with time and temperature, and trimmability using YAG laser processing. Plated gold conductors were patterned on diamond to feature sizes of 25 microns and successfully tested for adhesion and bondability. Advanced YAG laser trimming techniques were developed to allow resistor trims on both low and high value resistors to within 1% of design value while maintaining required resistor stability, new trim techniques were needed to offset the carbonization of diamond in the laser trim area. Reliability studies were carried out on the diamond thin film networks which showed them to compare favorably with the same thin film technology on alumina substrates. DOE

N93-28459# Sandia National Labs., Albuquerque, NM.
APPLICATION OF QUALITY FUNCTION DEPLOYMENT TO THE DESIGN OF A LITHIUM BATTERY
L. Halbleib, P. Wormington, W. Cieslak, and H. Street 1992 5 p Presented at the 43rd Electronic Component and Technology Conference, Orlando, FL, 1-3 Jun. 1993
(Contract DE-AC04-76DP-00789)
(DE93-008346; SAND-92-2345C; CONF-9306104-1) Avail: CASI HC A01/MF A01

Quality Function Deployment (QFD) is the tool we have selected to aid in the design, development and subsequent commercial manufacture of a Lithium/Thionyl Chloride 'D' cell for use in weapons applications. QFD is a structured methodology used to help assure that customer needs and expectations will be satisfied throughout the product life cycle. In this paper, we will describe our application of QFD, some of the lessons learned, and what we expect to be the final product of this QFD exercise. DOE

N93-27575*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
DEVELOPMENT OF SUPERCONDUCTING YBa2Cu3O(x) WIRES WITH LOW RESISTANCE ELECTRICAL CONTACTS
A. M. Buoncristiani, C. E. Byvik, R. Caton (Christopher Newport Coll., Newport News, VA.), R. Selim (Christopher Newport Coll., Newport News, VA.), B. I. Lee (Clemson Univ., SC.), V. Modi (Clemson Univ., SC.), M. Sherrill (Clemson Univ., SC.), H. D. Leigh (Clemson Univ., SC.), C. C. Fain (Clemson Univ., SC.), and G. Lewis (Clemson Univ., SC.) et al *In its* Magnetic Suspension Technology Workshop 1993 p 343-357 (For primary document see N93-27554 10-18)
(Grants NAG1-796; NAG1-820)
Avail: CASI HC A03/MF A03

N93-27730*# California Univ., Los Angeles. Dept. of Electrical Engineering.
THE 2X2 QUASI-OPTICAL POWER COMBINER ARRAY AT 20 GHz
Shigeo Kawasaki and Tatsuo Itoh *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 37-44 (For primary document see N93-27726 10-31)
(Contract DAAL03-88-K-0005)
Avail: CASI HC A02/MF A06

N93-27731*# California Univ., Los Angeles. Center for High Frequency Electronics.
MONOLITHIC MILLIMETER-WAVE DIODE ARRAY BEAM CONTROLLERS: THEORY AND EXPERIMENT
L. B. Sjogren, H.-X. L. Liu, F. Wang, T. Liu, W. Wu, X.-H. Qin, E. Chung, C. W. Domier, N. C. Luhmann, Jr., and J. Maserjian (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) et al *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 45-57 Sponsored in part by Northrop Corp.; DOE; and ARO (For primary document see N93-27726 10-31)
Avail: CASI HC A03/MF A06

N93-27732*# Michigan Univ., Ann Arbor. NASA Center for Space Terahertz Technology.
A STUDY OF SUBTERAHERTZ HEMT MONOLITHIC OSCILLATORS
Youngwoo Kwon and Dimitris Pavlidis *In its* The Third International

Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 58-72 (For primary document see N93-27726 10-31)
Avail: CASI HC A03/MF A06

N93-27733*# Virginia Univ., Charlottesville. Semiconductor Device Lab.
VARACTOR DIODES FOR MILLIMETER AND SUBMILLIMETER WAVELENGTHS
Brian J. Rizzi, Jeffrey L. Hesler, Hasan Dossal, and Thomas W. Crowe *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 73-92 Sponsored in part by JPL (For primary document see N93-27726 10-31)
(Grant NSF ECS-87-20850)
Avail: CASI HC A03/MF A06

N93-27734*# Virginia Univ., Charlottesville. Semiconductor Device Lab.
A SCHOTTKY/2-DEG VARACTOR DIODE FOR MILLIMETER AND SUBMILLIMETER WAVE MULTIPLIER APPLICATIONS
W. C. B. Peatman, Thomas W. Crowe, M. Shur, and B. Gelmont *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 93-109 (For primary document see N93-27726 10-31)
(Contract N00014-90-J-4006; NSF ECS-87-20850; NSF ECS-91-13123)
Avail: CASI HC A03/MF A06

N93-27735*# Chalmers Univ. of Technology, Goeteborg (Sweden). Applied Electron Physics.
THERMIONIC EMISSION CURRENT IN A SINGLE BARRIER VARACTOR
Hans Hjelmgren, Jack East (Michigan Univ., Ann Arbor.), and Erik Kollberg *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 110-114 (For primary document see N93-27726 10-31)
Avail: CASI HC A01/MF A06

N93-27736*# Chalmers Univ. of Technology, Goeteborg (Sweden). Millimeter Wave Group.
PROGRESS ON SINGLE BARRIER VARACTORS FOR SUBMILLIMETER WAVE POWER GENERATION
Svein M. Nilsen, Hans Groenqvist, Hans Hjelmgren, Anders Rydberg, and Erik L. Kollberg *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 115-133 Sponsored in part by Swedish National Board for Industrial and Technical Development (For primary document see N93-27726 10-31)
(Contract ESA-7898/88/NL/PB(SC))
Avail: CASI HC A03/MF A06

N93-27737*# Helsinki Univ. of Technology, Espoo (Finland). Radio Lab.
EFFECT OF COOLING ON THE EFFICIENCY OF SCHOTTKY VARACTOR FREQUENCY MULTIPLIERS AT MILLIMETER WAVES
Jyrki Louhi, Antti Raiesanen, and Neal Erickson (Five-College Astronomy Dept., Amherst, MA.) *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 134-145 (For primary document see N93-27726 10-31)
Avail: CASI HC A03/MF A06

N93-27738*# Michigan Univ., Ann Arbor. Solid State Electronics Lab.
SUPERLATTICE BARRIER VARACTORS
C. Raman, J. P. Sun, W. L. Chen, G. Munns, J. East, and G. Haddad *In its* The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 146-157 (For primary document see N93-27726 10-31)
(Contract DAAL03-87-K-0007)
Avail: CASI HC A03/MF A06

N93-27739*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
A NEW FABRICATION TECHNIQUE FOR BACK-TO-BACK VARACTOR DIODES
R. Peter Smith, Debabani Choudhury, Suzanne Martin, Margaret A. Frerking, John K. Liu, and Frank A. Grunthaner *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 158-163 Sponsored in part by ARO (For primary document see N93-27726 10-31)
Avail: CASI HC A02/MF A06

N93-27740*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
A 200 GHz TRIPLER USING SINGLE BARRIER VARACTOR
Debabani Choudhury, Margaret A. Frerking, and Paul D. Batelaan *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 164-180 (For primary document see N93-27726 10-31)
Avail: CASI HC A03/MF A06

N93-27741*# Five-College Astronomy Dept., Amherst, MA.
A SUBMILLIMETER TRIPLER USING A QUASI-WAVEGUIDE STRUCTURE
Neal R. Erickson and German Cortes-Medellin *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 181-188 (For primary document see N93-27726 10-31)
Avail: CASI HC A02/MF A06

N93-27743*# Groningen Rijksuniv. (Netherlands).
A LOW NOISE 410-495 HETERODYNE TWO TUNER MIXER, USING SUBMICRON Nb/Al2O3/Nb TUNNELJUNCTIONS
G. deLange, C. E. Honingh (Space Research Organization Netherlands, Groningen.), M. M. T. M. Dierichs, R. A. Panhuyzen, H. H. A. Schaeffer (Space Research Organization Netherlands, Groningen.), T. M. Klapwijk, H. vandeStadt (Space Research Organization Netherlands, Groningen.), and M. W. M. deGraauw (Space Research Organization Netherlands, Groningen.) *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 210-221 Sponsored in part by Stichting Technische Wetenschappen and Stichting voor Fundamenteel Onderzoek der Materie (For primary document see N93-27726 10-31)
(Contract ESA-7898/88/NL/PB(SC))
Avail: CASI HC A03/MF A06

N93-27744*# Chalmers Univ. of Technology, Goeteborg (Sweden). Dept. of Applied Electron Physics.
DOUBLE DIPOLE ANTENNA SIS RECEIVERS AT 100 AND 400 GHz
A. Skalare (Space Research Organization Netherlands, Groningen.), H. vandeStadt (Space Research Organization Netherlands, Groningen.), T. deGraauw (Space Research Organization Netherlands, Groningen.), R. A. Panhuyzen (Groningen Rijksuniv., Netherlands.), and M. M. T. M. Dierichs (Groningen Rijksuniv., Netherlands.) *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 222-233 (For primary document see N93-27726 10-31)
(Contract ESA-7898/88/NL/PB(SC))
Avail: CASI HC A03/MF A06

N93-27746*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
A PLANAR QUASI-OPTICAL SIS RECEIVER FOR ARRAY APPLICATIONS
Philip A. Stimson, Robert J. Dengler, Peter H. Siegel, and Henry G. LeDuc *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 235-242 (For primary document see N93-27726 10-31)
Avail: CASI HC A02/MF A06

N93-27747*# California Inst. of Tech., Pasadena. Div. of Physics, Mathematics and Astronomy.
A FIXED TUNED BROADBAND MATCHING STRUCTURE FOR SUBMILLIMETER SIS RECEIVERS Abstract Only
Thomas H. Buettgenbach, Henry G. LeDuc (Jet Propulsion Lab., California Inst. of Tech., Pasadena.), Paul D. Maker (Jet Propulsion Lab., California Inst. of Tech., Pasadena.), and T. G. Phillips *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 243 (For primary document see N93-27726 10-31)
Avail: CASI HC A01/MF A06

N93-27748*# Institut de Radio Astronomie Millimetrique, Saint Martin d'Heres (France).
MODELLING AND PERFORMANCE OF Nb SIS MIXERS IN THE 1.3 mm AND 0.8 mm BANDS
A. Karpov, M. Carter, B. Lazareff, D. Billon-Pierron, and K. H. Gundlach *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 244-250 (For primary document see N93-27726 10-31)
Avail: CASI HC A02/MF A06

N93-27749*# Space Research Organization Netherlands, Groningen.
COMPARISON OF MEASURED AND PREDICTED PERFORMANCE OF A SIS WAVEGUIDE MIXER AT 345 GHz
C. E. Honingh, G. deLange (Groningen Rijksuniv., Netherlands.), M. M. T. M. Dierichs (Groningen Rijksuniv., Netherlands.), H. H. A. Schaeffer, J. Wezelman, J. vandeKuur (Groningen Rijksuniv., Netherlands.), T. deGraauw, and T. M. Klapwijk (Groningen Rijksuniv., Netherlands.) *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 251-265 (For primary document see N93-27726 10-31)
(Contract ESA-7898/88/NL/PB(SC))
Avail: CASI HC A03/MF A06

N93-27750*# California Inst. of Tech., Pasadena.
A LOW-NOISE 492 GHz SIS WAVEGUIDE RECEIVER
C. K. Walker, J. W. Kooi, M. Chan, Henry G. LeDuc (Jet Propulsion Lab., California Inst. of Tech., Pasadena.), P. L. Schaffer, J. E. Carlstrom, and T. G. Phillips *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 266-279 (For primary document see N93-27726 10-31)
(Grant NSF AST-90-15755)
Avail: CASI HC A03/MF A06

N93-27752*# Clemson Univ., SC. Dept. of Electrical and Computer Engineering.
QUASI-OPTICAL ANTENNA-MIXER-ARRAY DESIGN FOR TERAHERTZ FREQUENCIES
Yong Guo, Kent A. Potter (California Inst. of Tech., Pasadena.), and David B. Rutledge (California Inst. of Tech., Pasadena.) *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 291-297 Sponsored in part by Aerojet Electrosystems Co. and ARO (For primary document see N93-27726 10-31)
Avail: CASI HC A02/MF A06

N93-27758*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
ONSET OF DISPERSION IN Nb MICROSTRIP TRANSMISSION LINES AT SUBMILLIMETER WAVE FREQUENCIES
H. H. S. Javadi, William R. McGrath, B. Bumble, and Henry G. LeDuc *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 362-381 Sponsored in part by Strategic Defense Initiative Organization (For primary document see N93-27726 10-31)
Avail: CASI HC A03/MF A06

N93-27760*# National Radio Astronomy Observatory, Charlottesville, VA.
EMBEDDING IMPEDANCE APPROXIMATIONS IN THE ANALYSIS OF SIS MIXERS
A. R. Kerr, S.-K. Pan, and S. Withington (Cambridge Univ., England.) *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 394-407 Sponsored in part by NSF (For primary document see N93-27726 10-31)
Avail: CASI HC A03/MF A06

N93-27761*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
SUB MICRON AREA Nb/AlO(x)/Nb TUNNEL JUNCTIONS FOR SUBMILLIMETER MIXER APPLICATIONS
Henry G. LeDuc, B. Bumble, S. R. Cypher, A. J. Judas, and J. A. Stern *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 408-418 Sponsored in part by Strategic Defense Initiative Organization (For primary document see N93-27726 10-31)
Avail: CASI HC A03/MF A06

N93-27762*# California Inst. of Tech., Pasadena.
NOISE IN JOSEPSON EFFECT MIXERS AND THE RSJ MODEL Abstract Only
R. Schoelkopf, T. Phillips, and J. Zmuidzinas *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 419 (For primary document see N93-27726 10-31)
Avail: CASI HC A01/MF A06

N93-27764*# Massachusetts Inst. of Tech., Lexington. Lincoln Lab.
A QUASIOPTICAL RESONANT-TUNNELING-DIODE OSCILLATOR OPERATING ABOVE 200 GHz Abstract Only
E. R. Brown, C. D. Parker, K. M. Molvar, A. R. Calawa, and M. J. Manfra *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 439 Sponsored in part by ARO (For primary document see N93-27726 10-31)
Avail: CASI HC A01/MF A06

N93-27765*# Michigan Univ., Ann Arbor. NASA Center for Space Terahertz Technology.
TRANSIT-TIME DEVICES AS LOCAL OSCILLATORS FOR FREQUENCIES ABOVE 100 GHz
H. Eisele, C. Kidner, and G. I. Haddad *In its* The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 440-456 (For primary document see N93-27726 10-31)
Avail: CASI HC A03/MF A06

N93-27766*# Utah Univ., Salt Lake City. Dept. of Electrical Engineering.
NEGATIVE DIFFERENTIAL RESISTANCE (NDR) FREQUENCY CONVERSION WITH GAIN
R. J. Hwu, R. W. Alm, and S. C. Lee *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 457-476 (For primary document see N93-27726 10-31)
Avail: CASI HC A03/MF A06

N93-27767*# Michigan Univ., Ann Arbor. Solid-State Electronics Lab.
MODELING, DESIGN, FABRICATION, AND TESTING OF InP GUNN DEVICES IN THE D-BAND (110 GHz - 170 GHz)
R. Kamoua, H. Eisele, J. R. East, G. I. Haddad, G. Munns, and M. Sherwin *In its* The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 477-493 (For primary document see N93-27726 10-31)
Avail: CASI HC A03/MF A06

N93-27768*# Cambridge Univ. (England). Cavendish Lab.
RECENT ADVANCES IN SUPERCONDUCTING-MIXER SIMULATIONS
S. Withington and P. R. Kennedy *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 494-501 (For primary document see N93-27726 10-31)
Avail: CASI HC A02/MF A06

N93-27769*# Rochester Univ., NY.
SUBMILLIMETER WAVE DETECTION WITH SUPERCONDUCTING TUNNEL DIODES
Michael J. Wengler *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 502-521 (For primary document see N93-27726 10-31)
(Grant NSF ECS-88-57868)
Avail: CASI HC A03/MF A06

N93-27770*# Groningen Rijksuniv. (Netherlands). Dept. of Applied Physics.
EVALUATION OF INTEGRATED TUNING ELEMENTS WITH SIS DEVICES
M. M. T. M. Dierichs, C. E. Honingh (Space Research Organization Netherlands, Groningen.), R. A. Panhuyzen (Space Research Organization Netherlands, Groningen.), B. J. Feenstra, A. Skalare (Space Research

Organization Netherlands, Groningen.), J. J. Wijnbergen (Space Research Organization Netherlands, Groningen.), H. vanderStadt (Space Research Organization Netherlands, Groningen.), and T. deGraauw (Space Research Organization Netherlands, Groningen.) *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 522-537 Sponsored in part by Stichting Technische Wetenschappen and Stichting voor Fundamenteel Onderzoek der Materie (For primary document see N93-27726 10-31)
(Contract ESA-7898/88/NL/PB(SC))
Avail: CASI HC A03/MF A06

N93-27771*# Rochester Univ., NY. Dept. of Physics.
SOURCE CONDUCTANCE SCALING FOR HIGH FREQUENCY SUPERCONDUCTING QUASIPARTICLE RECEIVERS
Qing Ke and M. J. Feldman *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 538-547 Sponsored in part by AFOSR and NSF (For primary document see N93-27726 10-31)
Avail: CASI HC A02/MF A06

N93-27772*# Lille-1 Univ., Villeneuve-d'Asoq (France). Centre Hyperfrequences et Semiconducteurs.
RESONANT TUNNELING DIODES AS SOURCES FOR MILLIMETER AND SUBMILLIMETER WAVELENGTHS
O. Vanbesien, R. Bouregba, P. Mounaix, D. Lippens, L. Palmateer, J. C. Pernot, G. Beaudin (Observatoire de Paris-Meudon, France.), P. Encrenaz, E. Bockenhoff (Thomson-CSF, Orsay, France.), and J. Nagle (Thomson-CSF, Orsay, France.) et al *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 548-559 Sponsored in part by Ministere de la Recherche et de la Technologie (For primary document see N93-27726 10-31)
Avail: CASI HC A03/MF A06

N93-27773*# Texas Univ., Austin. Dept. of Electrical and Computer Engineering.
SIMULATION OF ELECTRON TRANSPORT IN QUANTUM WELL DEVICES
D. R. Miller, K. K. Gullapalli, V. R. Reddy, and D. P. Neikirk *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 560-574 Sponsored in part by Texas Advance Research Program (For primary document see N93-27726 10-31)
Avail: CASI HC A03/MF A06

N93-27774*# Rochester Univ., NY. Dept. of Electrical Engineering.
PARALLEL ARRAYS OF JOSEPHSON JUNCTIONS FOR SUBMILLIMETER LOCAL OSCILLATORS
Aleksandar Pance and Michael J. Wengler *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 575-594 (For primary document see N93-27726 10-31)
(Grant AF-AFOSR-0233-90)
Avail: CASI HC A03/MF A06

N93-27775*# California Univ., Los Angeles. Center for High Frequency Electronics.
MONOLITHIC MILLIMETER-WAVE DIODE GRID FREQUENCY MULTIPLIER ARRAYS
Hong-Xia L. Liu, X.-H. Qin, L. B. Sjogren, W. Wu, E. Chung, C. W. Domier, and N. C. Luhmann, Jr. *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 595-599 Sponsored in part by ARO and DOE (For primary document see N93-27726 10-31)
Avail: CASI HC A01/MF A06

N93-27776*# Virginia Univ., Charlottesville. Semiconductor Device Lab.
PLANAR GaAs DIODES FOR THz FREQUENCY MIXING APPLICATIONS
William L. Bishop, Thomas W. Crowe, Robert J. Mattauch, and Hasan Dossal *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 600-615 Sponsored in part by ARO and JPL (For primary document see N93-27726 10-31)
(Grant NSF ECS-87-20850)
Avail: CASI HC A03/MF A06

N93-27777*# Michigan Univ., Ann Arbor. NASA Center for Space Terahertz Technology.
PLANAR DOPED BARRIER SUBHARMONIC MIXERS
T. H. Lee, J. R. East, and G. I. Haddad *In its* The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 616-630 (For primary document see N93-27726 10-31)
Avail: CASI HC A03/MF A06

N93-27778*# Technische Hochschule, Darmstadt (Germany). Inst. fuer Hochfrequenztechnik.
NEW APPROACH TO THE DESIGN OF SCHOTTKY BARRIER DIODES FOR THz MIXERS
A. Jelenski (Polish Academy of Sciences, Warsaw.), A. Grueb, V. Krozer, and H. L. Hartnagel *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 631-642 (For primary document see N93-27726 10-31)
Avail: CASI HC A03/MF A06

N93-27779*# National Inst. of Standards and Technology, Boulder, CO. Electromagnetic Technology Div.
ELECTRICAL AND INFRARED PROPERTIES OF THIN NIOBIUM MICROBOLOMETERS NEAR T(SUB c)
E. N. Grossman, J. E. Sauvageau, and D. G. McDonald *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 643-653 Sponsored in part by Strategic Defense Initiative Organization (For primary document see N93-27726 10-31)
Avail: CASI HC A03/MF A06

N93-27780*# Bremen Univ. (Germany). Inst. of Remote Sensing.
MEASUREMENTS OF THE SINGLE SIDEBAND SUPPRESSION FOR A 650 GHz HETERODYNE RECEIVER
S. Crewell and H. Nett *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 654-660 (For primary document see N93-27726 10-31)
Avail: CASI HC A02/MF A06

N93-27781*# Virginia Univ., Charlottesville. Semiconductor Device Lab.
InGaAs/InP HETEROEPITAXIAL SCHOTTKY BARRIER DIODES FOR TERAHERTZ APPLICATIONS
Udayan V. Bhapkar, Yongjun Li, and Robert J. Mattauch *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 661-677 (For primary document see N93-27726 10-31)
(Grant NSF ECS-91-13123)
Avail: CASI HC A03/MF A06

N93-27783*# Massachusetts Univ., Amherst. Dept. of Electrical and Computer Engineering.
AlGaAs/GaAs QUASI-BULK EFFECT MIXERS: ANALYSIS AND EXPERIMENTS
K. S. Yngvesson, J.-X. Yang, F. Agahi, D. Dai, C. Musante, W. Grammer, and K. M. Lau *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 688-705 (For primary document see N93-27726 10-31)
(Grant NAGw-1659)
Avail: CASI HC A03/MF A06

N93-27784*# Radiometer-Physics G.m.b.H., Meckenheim (Germany).
ALL-SOLID-STATE RADIOMETERS FOR ENVIRONMENTAL STUDIES TO 700 GHz
Ralph Zimmermann, Ruediger Zimmermann, and Peter Zimmermann *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 706-723 (For primary document see N93-27726 10-31)
Avail: CASI HC A03/MF A06

N93-27804*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ELECTRICAL POWER SYSTEM WP-04
Donald L. Nored *In* NASA, Washington, Technology for Space Station Evolution. Volume 4: Power Systems/Propulsion/Robotics 1990 p 5-61 (For primary document see N93-27803 10-18)
Avail: CASI HC A04/MF A04; 1 functional color page

N93-27805*# Rockwell International Corp., Canoga Park, CA. Rocketdyne Div.
SPACE STATION FREEDOM SOLAR DYNAMIC POWER GENERATION
T. Springer and Jerry M. Friefeld *In* NASA, Washington, Technology for Space Station Evolution. Volume 4: Power Systems/Propulsion/Robotics 1990 p 65-81 (For primary document see N93-27803 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

N93-27807*# Ford Aerospace Corp., Newport Beach, CA.
SPACE STATION FREEDOM ELECTRIC POWER SYSTEM EVOLUTIONARY ENERGY STORAGE
Mike Domeniconi *In* NASA, Washington, Technology for Space Station Evolution. Volume 4: Power Systems/Propulsion/Robotics 1990 p 117-121 (For primary document see N93-27803 10-18)
Avail: CASI HC A01/MF A04; 1 functional color page

N93-27809*# Applied Solar Energy Corp., City of Industry, CA.
HIGH EFFICIENCY LOW COST GaAs/Ge CELL TECHNOLOGY
Frank Ho *In* NASA, Washington, Technology for Space Station Evolution. Volume 4: Power Systems/Propulsion/Robotics 1990 p 129-137 (For primary document see N93-27803 10-18)
Avail: CASI HC A02/MF A04; 1 functional color page

N93-27810*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
GROWING THE SPACE STATION'S ELECTRICAL POWER PLANT
Gale R. Sundberg *In* NASA, Washington, Technology for Space Station Evolution. Volume 4: Power Systems/Propulsion/Robotics 1990 p 139-150 (For primary document see N93-27803 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

34 FLUID MECHANICS AND HEAT TRANSFER

Includes boundary layers; hydrodynamics; fluidics; mass transfer; and ablation cooling.

For related information see also *02 Aerodynamics* and *77 Thermodynamics and Statistical Physics.*

N93-26620# Maryland Univ., College Park. Dept. of Mechanical Engineering.
DIFFUSION-ABSORPTION HEAT PUMP Annual Report, Nov. 1991 - Oct. 1992
K. E. Herold and J. Chen 4 Jan. 1993 149 p See also PB92-217538
(Contract GRI-5090-260-2041)
(PB93-165777; GRI-93/0055) Avail: CASI HC A07/MF A02

The diffusion-absorption heat pump (DAHP) offers advantages including no moving parts, noise and vibration free operation and operation without electric power. An example of such a cycle is the gas-fired domestic refrigerator. The cycle is similar to an absorption cycle but differs in that an auxiliary gas is used to equalize the pressures throughout the system and to allow a heat driven bubble pump. The effort covered by the report focused primarily on an experimental evaluation of DAHP performance. This involved testing of several machines over a wide range of conditions including: variable ambient temperature, hydrogen and helium gas, variable power input, variable charge pressure and variable evaporator load. The results are extensively documented. One particularly interesting result was that the machines worked reasonably well with helium in place of hydrogen. Although helium resulted in some performance degradation, the safety advantage of helium may indicate it as the preferred choice for some applications. NTIS

N93-26896*# Institute for Computer Applications in Science and Engineering, Hampton, VA.
ON THE INSTABILITY OF THE FLOW IN AN OSCILLATING TANK OF FLUID Final Report
Philip Hall (Manchester Univ., England.) Washington Feb. 1993 33 p Submitted for publication
(Contract NAS1-19480)
(NASA-CR-191424; NAS 1.26:191424; ICASE-93-3) Avail: CASI HC A03/MF A01

The instability of a viscous fluid inside a rectangular tank oscillating about an axis parallel to the largest face of the tank is investigated in the linear regime. The flow is shown to be unstable to both longitudinal roll and standing wave instabilities. The particular cases of low and high oscillation frequencies are discussed in detail and the results obtained for the standing wave instability at low frequencies shed light on the corresponding steady flow instability problem. The relationship between the roll instability and convective or centrifugal instabilities in unsteady boundary layers is discussed. The eigenvalue problems associated with the roll and standing wave instabilities are solved using Floquet theory and a combination of numerical and asymptotic methods. The results obtained are compared to the recent experimental investigation of Bolton and Maurer (1992). Author (revised)

N93-26998*# Institute for Computer Applications in Science and Engineering, Hampton, VA.
A NUMERICAL STUDY OF WAVE PROPAGATION IN A CONFINED MIXING LAYER BY EIGENFUNCTION EXPANSIONS Final Report
Fang Q. Hu Mar. 1993 21 p Submitted for publication
(Contract NAS1-19480; RTOP 505-90-52-01)
(NASA-CR-191433; NAS 1.26:191433; ICASE-93-8) Avail: CASI HC A03/MF A01

It is well known that the growth rate of instability waves of a two-dimensional free shear layer is reduced greatly at supersonic convective Mach numbers. In previous works, it has been shown that new wave modes exist when the shear layers are bounded by a channel due to the coupling effect between the acoustic wave modes and the motion of the mixing layer. The present work studies the simultaneous propagation of multiple stability waves using numerical simulation. It is shown here that the co-existence of two wave modes in the flow field can lead to an oscillatory growth of disturbance energy with each individual wave mode propagating linearly. This is particularly important when the growth rates of the unstable waves are small. It is also shown here that the propagation of two neutrally stable wave modes can lead to a stationary periodic structure of RMS fluctuations. In the numerical simulations presented here, the forced wave modes are propagating at the same frequency but with different phase velocities. In order to track the growth of each wave mode as it propagates downstream, a numerical method which can effectively detect and separate the contribution of an individual wave is given. It is demonstrated that by a least square fitting of the disturbance field with eigenfunctions, the amplitude of each wave mode can be found. Satisfactory results as compared to linear theory are obtained. Author

N93-27008*# Institute for Computer Applications in Science and Engineering, Hampton, VA.
EFFECT OF ROTATION RATE ON THE FORCES OF A ROTATING CYLINDER: SIMULATION AND CONTROL Final Report
John A. Burns (Virginia Polytechnic Inst. and State Univ., Blacksburg.) and Yuh-Roung Ou (Virginia Polytechnic Inst. and State Univ., Blacksburg.) Washington Mar. 1993 49 p Submitted for publication
(Contracts NAS1-18605; NAS1-19480; F49620-92-J-0078; NSF INT-89-22490; RTOP 505-90-52-01)
(NASA-CR-191442; NAS 1.26:191442; ICASE-93-11) Avail: CASI HC A03/MF A01

In this paper we present numerical solutions to several optimal control problems for an unsteady viscous flow. The main thrust of this work is devoted to simulation and control of an unsteady flow generated by a circular cylinder undergoing rotary motion. By treating the rotation rate as a control variable, we can formulate two optimal control problems and use a central difference/pseudospectral transform method to numerically compute the optimal control rates. Several types of rotations are considered as potential controls, and we show that a proper synchronization of forcing frequency with the natural vortex shedding frequency can greatly influence

the flow. The results here indicate that using moving boundary controls for such systems may provide a feasible mechanism for flow control.
Author (revised)

N93-27010*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
REMARKS ON TURBULENT CONSTITUTIVE RELATIONS
Tsan-Hsing Shih and John L. Lumley (Cornell Univ., Ithaca, NY.) May 1993 12 p
(Contract NCC3-233; RTOP 505-90-5X)
(NASA-TM-106116; E-7770; NAS 1.15:106116; ICOMP-93-12; CMOTT-93-6)
Avail: CASI HC A03/MF A01

The paper demonstrates that the concept of turbulent constitutive relations can be used to construct general models for various turbulent correlations. Some of the Generalized Cayley-Hamilton formulas for relating tensor products of higher extension to tensor products of lower extension are introduced. The combination of dimensional analysis and invariant theory can lead to 'turbulent constitutive relations' (or general turbulence models) for, in principle, any turbulent correlations. As examples, the constitutive relations for Reynolds stresses and scalar fluxes are derived. The results are consistent with ones from Renormalization Group (RNG) theory and two-scale Direct-Interaction Approximation (DIA) method, but with a more general form. Author (revised)

N93-27020*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
INCREASED HEAT TRANSFER TO ELLIPTICAL LEADING EDGES DUE TO SPANWISE VARIATIONS IN THE FREESTREAM MOMENTUM: NUMERICAL AND EXPERIMENTAL RESULTS
D. L. Rigby (Sverdrup Technology, Inc., Brook Park, OH.) and G. J. VanFossen Jul. 1992 13 p Presented at the 28th Joint Propulsion Conference and Exhibit, Nashville, TN, 6-8 Jul. 1992; sponsored by AIAA, SAE, ASME, and ASEE
(RTOP 505-62-52)
(NASA-TM-106150; E-7835; NAS 1.15:106150; AIAA Paper 92-3070)
Avail: CASI HC A03/MF A01

A study of the effect of spanwise variation in momentum on leading edge heat transfer is discussed. Numerical and experimental results are presented for both a circular leading edge and a 3:1 elliptical leading edge. Reynolds numbers in the range of 10,000 to 240,000 based on leading edge diameter are investigated. The surface of the body is held at a constant uniform temperature. Numerical and experimental results with and without spanwise variations are presented. Direct comparison of the two-dimensional results, that is, with no spanwise variations, to the analytical results of Frossling is very good. The numerical calculation, which uses the PARC3D code, solves the three-dimensional Navier-Stokes equations, assuming steady laminar flow on the leading edge region. Experimentally, increases in the spanwise-averaged heat transfer coefficient as high as 50 percent above the two-dimensional value were observed. Numerically, the heat transfer coefficient was seen to increase by as much as 25 percent. In general, under the same flow conditions, the circular leading edge produced a higher heat transfer rate than the elliptical leading edge. As a percentage of the respective two-dimensional values, the circular and elliptical leading edges showed similar sensitivity to span wise variations in momentum. By equating the root mean square of the amplitude of the spanwise variation in momentum to the turbulence intensity, a qualitative comparison between the present work and turbulent results was possible. It is shown that increases in leading edge heat transfer due to spanwise variations in freestream momentum are comparable to those due to freestream turbulence. Author

N93-27049# Oak Ridge National Lab., TN.
THE ROLE OF GAS HEAT PUMPS IN ELECTRIC DSM
M. Fulmer (Tellus Inst., Inc., Boston, MA.) and P. J. Hughes 1993 12 p Presented at the 6th National Demand-Side Management Conference, Miami, FL, 24-26 Mar. 1993
(Contract DE-AC05-84OR-21400)
(DE93-007858; CONF-930329-1) Avail: CASI HC A03/MF A01

Natural gas-fired heat pumps (GHP's), an emerging technology, may offer environmental economic, and energy benefits relative to standard and advanced space conditioning equipment now on the market. This paper describes an analysis of GHP's for residential space heating, and cooling relative to major competing technologies under an Integrated Resource (IRP) framework. Our study models a hypothetical GHP rebate program using conditions typical of the Great Lakes region. The analysis is performed for a base scenario with sensitivity cases. In the base scenario, the GHP program is cost-effective according to the societal test, total resource cost test (TRC), and the participant test, but is not cost-effective according to the non-participant test. The sensitivity analyses indicate that the results for the TRC test are most sensitive to the season in which electric demand peaks and the technology against which the GHP's are competing, and are less sensitive to changes in the marginal administrative costs. The modeled GHP program would save 900 million kWh over the life of the program and reduce peak load by about 100 MW in winter and about 135 MW in summer. We estimate all of the GHP's in service (both GHP's of program participants and nonparticipants) in the case study region would save 1,900 million kWh and reduce summer peak load by over 350 MW. DOE

N93-27091*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
POSITIVITY-PRESERVING NUMERICAL SCHEMES FOR MULTIDIMENSIONAL ADVECTION
B. P. Leonard, M. K. MacVean (Meteorological Office, Bracknell, England.), and A. P. Lock (Meteorological Office, Bracknell, England.) Mar. 1993 63 p
(Contract NCC3-233; RTOP 505-90-5K)
(NASA-TM-106055; ICOMP-93-05; E-7656; NAS 1.15:106055) Avail: CASI HC A04/MF A01

This report describes the construction of an explicit, single time-step, conservative, finite-volume method for multidimensional advective flow, based on a uniformly third-order polynomial interpolation algorithm (UTOPIA). Particular attention is paid to the problem of flow-to-grid angle-dependent, anisotropic distortion typical of one-dimensional schemes used component-wise. The third-order multidimensional scheme automatically includes certain cross-difference terms that guarantee good isotropy (and stability). However, above first-order, polynomial-based advection schemes do not preserve positivity (the multidimensional analogue of monotonicity). For this reason, a multidimensional generalization of the first author's universal flux-limiter is sought. This is a very challenging problem. A simple flux-limiter can be found; but this introduces strong anisotropic distortion. A more sophisticated technique, limiting part of the flux and then restoring the isotropy-maintaining cross-terms afterwards, gives more satisfactory results. Test cases are confined to two dimensions; three-dimensional extensions are briefly discussed. Author

N93-27098*# Institute for Computer Applications in Science and Engineering, Hampton, VA.
ON THE INITIAL STAGES OF VORTEX WAVE INTERACTIONS IN HIGHLY CURVED BOUNDARY LAYER FLOWS Final Report
Philip Hall (Manchester Univ., England.) Washington Feb. 1993 33 p Submitted for publication
(Contracts NAS1-18605; NAS1-19480; RTOP 505-90-52-01)
(NASA-CR-191423; NAS 1.26:191423; ICASE-93-2) Avail: CASI HC A03/MF A01

The nonlinear interaction equations describing vortex-Rayleigh wave interactions in highly curved boundary layers are derived. These equations describe a strongly nonlinear interaction between an inviscid wave system and a streamwise vortex. The coupling between two structures is quite different than that found by Hall and Smith (1991) in the absence of wall curvature. Here the vortex is forced over a finite region of the flow rather than in the critical layer associated with the wave system. When the interaction takes place the wave system remains locally neutral as it moves downstream and it's self interaction drives a vortex field of the same magnitude as that driven by the wall curvature. This modification of the mean state then alters the wave properties and forces the wave amplitude to adjust itself in order that the wave frequency is constant. Solutions of the interaction equations are found for the initial stages of the interaction in the case when the wave amplitude is initially small. Our analysis suggests that finite amplitude disturbances can only exist when the vortex field is finite at the initial position where the interaction is stimulated. Author

N93-27132*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

BRUSH SEAL LOW SURFACE SPEED HARD-RUB CHARACTERISTICS

Robert C. Hendricks, Julie A. Carlile, and Anita D. Liang Jun. 1993 14 p Presented at the 29th AIAA Joint Propulsion Conference and Exhibit, Monterey, CA, 28-30 Jun. 1993; sponsored by AIAA, SAE, ASME, and ASEE

(RTOP 584-03-11)

(NASA-TM-106169; E-7868; NAS 1.15:106169; AIAA Paper 93-2534)

Avail: CASI HC A03/MF A01

The bristles of a 38.1-mm (1.5-in.) diameter brush seal were flexed by a tapered, 40-tooth rotor operating at 2600 rpm that provided sharp leading-edge impact of the bristles with hard rubbing of the rotor lands. Three separate tests were run with the same brush accumulating over 1.3 x 10(exp 9) flexure cycles while deteriorating 0.2 mm (0.008 in.) radially. In each, the test bristle incursion depth varied from 0.130 to 0.025 mm (0.005 to 0.001 in.) or less (start to stop), and in the third test the rotor was set 0.25 mm (0.010 in.) eccentric. Runout varied from 0.025 to 0.076 mm (0.001 to 0.003 in.) radially. The bristles wore but did not pull out, fracture, or fragment. Bristle and rotor wear debris were deposited as very fine, nearly amorphous, highly porous materials at the rotor groove leading edges and within the rotor grooves. The land leading edges showed irregular wear and the beginning of a convergent groove that exhibited sharp, detailed wear at the land trailing edges. Surface grooving, burnishing, 'whipping,' and hot spots and streaks were found. With a smooth-plug rotor, post-test leakage increased 30 percent over pretest leakage. Author (revised)

N93-27151*# Stanford Univ., CA. Dept. of Aeronautics and Astronautics.

THE GENERATION OF SIDE FORCE BY DISTRIBUTED SUCTION

Leonard Roberts and John Hong May 1993 15 p Sponsored by NASA. Ames Research Center

(NASA-CR-193129; NAS 1.26:193129; JIAA-TR-108) Avail: CASI HC A03/MF A01

This report provides an approximate analysis of the generation of side force on a cylinder placed horizontal to the flow direction by the application of distributed suction on the rearward side of the cylinder. Relationships are derived between the side force coefficients and the required suction coefficients necessary to maintain attached flow on one side of the cylinder, thereby inducing circulation around the cylinder and a corresponding side force. Author

N93-27155*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

COMPARING THE RESULTS OF AN ANALYTICAL MODEL OF THE NO-VENT FILL PROCESS WITH NO-VENT FILL TEST RESULTS FOR A 4.96 CUBIC METERS (175 CUBIC FEET) TANK

William J. Taylor and David J. Chato Feb. 1993 24 p Presented at the 28th Joint Propulsion Conference and Exhibit, Nashville, TN, 6-8 Jul. 1992; sponsored by AIAA, SAE, ASME, and ASEE Previously announced in IAA as A92-54007

(RTOP 506-48-00)

(NASA-TM-106018; E-7575; NAS 1.15:106018) Avail: CASI HC A03/MF A01

The NASA Lewis Research Center (NASA/LeRC) have been investigating a no-vent fill method for refilling cryogenic storage tanks in low gravity. Analytical modeling based on analyzing the heat transfer of a droplet has successfully represented the process in 0.034 m and 0.142 cubic m commercial dewars using liquid nitrogen and hydrogen. Recently a large tank (4.96 cubic m) was tested with hydrogen. This lightweight tank is representative of spacecraft construction. This paper presents efforts to model the large tank test data. The droplet heat transfer model is found to over predict the tank pressure level when compared to the large tank data. A new model based on equilibrium thermodynamics has been formulated. This new model is compared to the published large scale tank's test results as well as some additional test runs with the same equipment. The results are shown to match the test results within the measurement uncertainty of the test data except for the initial transient wall cooldown where it is conservative (i.e., overpredicts the initial pressure spike found in this time frame). Author (revised)

N93-27161*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

CALCULATIONS OF TURBULENT SEPARATED FLOWS

J. Zhu and T. H. Shih Aug. 1993 20 p Presented at the Second United States National Congress on Computational Mechanics, Washington, DC, 16-18 Aug. 1993; sponsored by The United States Association for Computational Mechanics

(RTOP 505-90-5K)

(NASA-TM-106154; E-7838; NAS 1.15:106154; ICOMP-93-13; CMOTT-93-5)

Avail: CASI HC A03/MF A01

A numerical study of incompressible turbulent separated flows is carried out by using two-equation turbulence models of the K-epsilon type. On the basis of realizability analysis, a new formulation of the eddy-viscosity is proposed which ensures the positiveness of turbulent normal stresses - a realizability condition that most existing two-equation turbulence models are unable to satisfy. The present model is applied to calculate two backward-facing step flows. Calculations with the standard K-epsilon model and a recently developed RNG-based K-epsilon model are also made for comparison. The calculations are performed with a finite-volume method. A second-order accurate differencing scheme and sufficiently fine grids are used to ensure the numerical accuracy of solutions. The calculated results are compared with the experimental data for both mean and turbulent quantities. The comparison shows that the present model performs quite well for separated flows. Author (revised)

N93-27250*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

THE ADDITION OF ALGEBRAIC TURBULENCE MODELING TO PROGRAM LAURA

F. McNeil Cheatwood (Vigyan Research Associates, Inc., Hampton, VA.) and R. A. Thompson Apr. 1993 34 p

(RTOP 506-40-91-01)

(NASA-TM-107758; NAS 1.15:107758) Avail: CASI HC A03/MF A01

The Langley Aerothermodynamic Upwind Relaxation Algorithm (LAURA) is modified to allow the calculation of turbulent flows. This is accomplished using the Cebeci-Smith and Baldwin-Lomax eddy-viscosity models in conjunction with the thin-layer Navier-Stokes options of the program. Turbulent calculations can be performed for both perfect-gas and equilibrium flows. However, a requirement of the models is that the flow be attached. It is seen that for slender bodies, adequate resolution of the boundary-layer gradients may require more cells in the normal direction than a laminar solution, even when grid stretching is employed. Results for axisymmetric and three-dimensional flows are presented. Comparison with experimental data and other numerical results reveal generally good agreement, except in the regions of detached flow. Author

N93-27299# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Numerical Mathematics.

ON STEADY, INVISCID SHOCK WAVES AT CONTINUOUSLY CURVED, CONVEX SURFACES

Barry Koren and Eric vanderMaarel Feb. 1992 24 p

(Contract AERO-0003/1094)

(CWI-NM-R9202; ETN-93-93256) Copyright Avail: CASI HC A03/MF A01

An accurate and efficient numerical method for the steady, two dimensional Euler equations is applied to study steady shock waves perpendicular to smooth, convex surfaces. The main subject of study is the flow near both ends of the shock waves. Some doubts are formulated about the correctness of a known analytical model of the inviscid shock foot flow. The numerical results presented do not show that this analytical model is incorrect. For the inviscid shock tip flow, two existing analytical solutions are discussed. The numerical results presented agree with one of these. Good numerical accuracy is achieved through a solution adaptive, higher order accurate finite volume discretization. Good computational efficiency is obtained by a multigrid acceleration technique. ESA

N93-27373# Technische Univ., Eindhoven (Netherlands).

ON WAVE PROPAGATION IN SATURATED AND PARTIALLY SATURATED POROUS MEDIA Ph.D. Thesis

David Maria Jacobus Smeulders 1992 136 p Original contains color illustrations

(ETN-93-93152) Avail: CASI HC A07/MF A02

The aim was to verify and improve models describing wave propagation and damping in partially saturated porous media. A survey of the two phase theory for wave propagation in fully saturated elastic media, which is usually denoted by the Biot theory is given. Computational results for wave propagation and damping in a cylindrical porous sample are presented. The damping mechanisms of vibrating gas bubbles on a porous system are discussed. Darcy damping, thermal damping, viscous damping, and acoustic damping are treated. The effects of oscillating gas bubbles in wave propagation and damping are considered. The dynamic compressibility of the pore fluid is introduced. The dynamic interaction between pore fluid and solid, a subject of interest for wave propagation in both fully and partially saturated porous media, is discussed. A dynamic permeability parameter is introduced. Experimental determination of the properties of the porous media and the preparation of a partially saturated column are discussed. An experimental determination of dynamic permeability is presented. Wave experiments performed on saturated and partially saturated porous media are discussed. ESA

N93-27411# Iowa Univ., Iowa City. Inst. of Hydraulic Research.
LEONARDIAN FLUID MECHANICS IN THE MANUSCRIPT F
E. Macagno Nov. 1992 297 p See also PB90-120262, PB90-121187 and PB92-146109 Sponsored by the National Science Foundation, and the National Endowment for the Humanities
(PB93-178853; IIHR-MONO-113) Avail: CASI HC A13

This is the thirteenth IIHR Monograph the author has written on the Leonardian science of flow and transport phenomena. The Manuscript F contains a great deal of notes and drawings on fluid mechanics and hydraulics and this is a volume requiring even more pages than the one for Ms I. Topics in the table of contents include: Methodology used in this study, Future work, Table I--Experiments and experimental situations in the Ms F, Table II--Analogies in the Ms F, and Leonardian fluid mechanics in the Ms F. NTIS

N93-27541# Nationaal Inst. voor Kernfysica en Hoge Energiefysica, Amsterdam (Netherlands).
RESULTS ON MONTE-CARLO SIMULATIONS OF A MICROSTRIP GAS COUNTER
J. Schmitz 1992 14 p Submitted for publication Sponsored by Stichting voor Fundamenteel Onderzoek der Materie, Netherlands
(NIKHEF-H/92-10; ETN-93-93303) Avail: CASI HC A03/MF A01

Results from Monte Carlo studies of the operation of a microstrip gas counter are presented. The Monte Carlo was tuned on data from test beam measurements using minimum ionizing particles and DME/CO2 60/40 as a counter gas. The position resolution of the detector for minimum ionizing particles in different geometries and as a function of the incoming angle of the particle was determined. A position resolution of about 20 microns can be obtained by increasing the gas gap and/or reducing the anode pitch. The performance of a thin gap microstrip gas counter is discussed. ESA

N93-27586*# Institute for Computer Applications in Science and Engineering, Hampton, VA.
PSEUDOSPECTRAL SIMULATION OF COMPRESSIBLE TURBULENCE USING LOGARITHMIC VARIABLES
John V. Shebalin Jan. 1993 22 p Sponsored by NASA, Washington
(RTOP 505-90-52-01)
(NASA-TM-107707; NAS 1.15:107707; ICASE-92-61) Avail: CASI HC A03/MF A01

The direct numerical simulation of dissipative highly compressible turbulent flow is performed using a pseudospectral Fourier technique. The governing equations are cast in a form where the important physical variables are the fluid velocity and the natural logarithms of the fluid density and temperature. Bulk viscosity is utilized to model polyatomic gases more accurately and to ensure numerical stability in the presence of strong shocks. Numerical examples include three-dimensional supersonic homogeneous turbulence and two-dimensional shock-turbulence interactions. Author

N93-27587*# Institute for Computer Applications in Science and Engineering, Hampton, VA.
ESTIMATING UNCERTAINTY IN COMPUTATIONS OF TWO-DIMENSIONAL SEPARATED FLOWS Final Report
A. O. Demuren and R. V. Wilson Washington NASA Dec. 1992 32 p Submitted for publication
(Contracts NAS1-18605; NAS1-19480; RTOP 505-90-52-01)
(NASA-CR-189743; NAS 1.26:189743; ICASE-92-69) Avail: CASI HC A03/MF A01

The present paper investigates sources of uncertainties in two-dimensional flow computations and presents methods for estimating them. Two sample problems are used for illustration. The following categories are explored in detail: (1) uncertainty due to truncation error in numerical schemes; (2) uncertainty due to discretization error; (3) uncertainty due to outflow boundary conditions; (4) uncertainty due to incomplete iterative convergence; (5) uncertainty due to computational grid aspect ratio. The error estimates are based on requirements for internal consistencies in computed results. Therefore, they provide better judgement of the numerical solution integrity than comparisons to experimental data or 'benchmark' solutions whose reliability may sometimes be questionable. Ideally, both approaches should be employed. New results are presented on the optimum grid-cell aspect ratio for computational accuracy and efficiency. Author (revised)

N93-27588*# Institute for Computer Applications in Science and Engineering, Hampton, VA.
SIMULATION OF BOUNDARY-LAYER TRANSITION: RECEPTIVITY TO SPIKE STAGE Final Report
Fabio P. Bertolotti and Jeffrey D. Crouch (Boeing Commercial Airplane Co., Seattle, WA.) Washington Dec. 1992 21 p Submitted for publication
(Contracts NAS1-18605; NAS1-19480; N00014-86-K-0759; RTOP 505-90-52-01)
(NASA-CR-191413; NAS 1.26:191413; ICASE-92-72) Avail: CASI HC A03/MF A01

The transition to turbulence in a boundary layer over a flat plate with mild surface undulations is simulated using the parabolized stability equations (PSE). The simulations incorporate the receptivity, the linear growth, and the nonlinear interactions leading to breakdown. The nonlocalized receptivity couples acoustic perturbations in the free stream with disturbances generated by the surface undulations to activate a resonance with the natural eigenmodes of the boundary layer. The nonlinear simulations display the influence of the receptivity inputs on transition. Results show the transition location to be highly sensitive to the amplitudes of both the acoustic disturbance and the surface waviness. Author

N93-27688*# Institute for Computer Applications in Science and Engineering, Hampton, VA.
A NEW DIRECTION IN HYDRODYNAMIC STABILITY: BEYOND EIGENVALUES Final Report
Lloyd N. Trefethen (Cornell Univ., Ithaca, NY.), Anne E. Trefethen (Cornell Univ., Ithaca, NY.), Satish C. Reddy (New York Univ., New York.), and Tobin A. Driscoll (Cornell Univ., Ithaca, NY.) Washington NASA Dec. 1992 32 p Submitted for publication
(Contract NAS1-19480; RTOP 505-90-52-01)
(NASA-CR-191411; NAS 1.26:191411; ICASE-92-71; AD-A261846) Avail: CASI HC A03/MF A01

Fluid flows that are smooth at low speeds become unstable and then turbulent at higher speeds. This phenomenon has traditionally been investigated by linearizing the equations of flow and looking for unstable eigenvalues of the linearized problem, but the results agree poorly in many cases with experiments. Nevertheless, it has become clear in recent years that linear effects play a central role in hydrodynamic instability. A reconciliation of these findings with the traditional analysis can be obtained by considering the 'pseudospectra' of the linearized problem, which reveals that small perturbations to the smooth flow in the form of streamwise vortices may be amplified by factors on the order of 10(exp 5) by a linear mechanism, even though all the eigenmodes are stable. The same principles apply also to other problems in the mathematical sciences that involve non-orthogonal eigenfunctions. Author

N93-27878# Technische Univ., Delft (Netherlands).
THE TURBULENT BOUNDARY LAYER: SPANWISE STRUCTURE, EVOLUTION OF LOW-VELOCITY REGIONS AND RESPONSE TO ARTIFICIAL DISTURBANCES Ph.D. Thesis

Arnold Joost Brand 1992 191 p In NEPALI
(ETN-93-93606) Avail: CASI HC A09/MF A02

A contribution to a better understanding of near wall turbulence by developing methods to measure, predict, and manipulate specific coherent structures is presented. The basic knowledge in (turbulent) boundary layer flow, its statistical and structural description, is introduced. A technique to measure spanwise profiles of the streamwise fluid velocity is developed and is used to study the structure of these profiles. The evolution in time of the flow in the near wall low velocity region is determined and this information is used to develop a simple model for this kind of flow. A mechanism by which nonrandom fluid motion can be generated artificially is developed. With this strategy it might be possible to measure, predict, and manipulate coherence motions, and, consequently, come to a better understanding of near wall turbulence. ESA

N93-27882# Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.

FREE BOUNDARY PROBLEMS IN FRESH-SALT GROUNDWATER FLOW

C. J. vanDuijn (Leiden Univ., Netherlands.) and G. deJisselinedeJong 1992 75 p
(Rept-92-45; ETN-93-93135) Copyright Avail: CASI HC A04/MF A01

Contribution density induced (that is, gravity driven, groundwater flow) problems in fluids with a low relative density difference are studied. This allows the assumption that the flow is incompressible. This situation occurs in the case of fresh and salt groundwater flow. It is also assumed that the scale of the problems is such that a description in terms of an abrupt transition between the fluids, an interface or free boundary between the fresh and salt water, is possible. The necessary physical properties of groundwater flow are discussed, Darcy's law is introduced and differential equations for the pressure and stream function are derived to describe the flow of a fluid with a variable density through a porous material. Some mathematical preliminaries are given, in particular the concepts of test functions and distributions are introduced. Also, expressions for the divergence and the curl of a vector field across a discontinuity are derived. The interface models are set up, two cases being treated in detail: a two dimensional fresh salt problem in a horizontal aquifer and an axially symmetric flow problem in which fresh water, on top of the heavier salt water, flows towards a well (the coning problem). For both cases a numerical method is given. A simplification which arises in many practical situations and which is called the Dupuit approximation is considered. In this approximation, it is assumed that the horizontal component of the specific discharge is constant (in the vertical direction) in each fluid and has a jump at the interface. It leads to a description in terms of a nonlinear diffusion equation. The mathematical theory for this equation is summarized, and some extensions, in particular adding convection terms, are discussed. ESA

N93-27884# Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.

STEADY INCOMPRESSIBLE FLOW AROUND OBJECTS IN GENERAL COORDINATES WITH A MULTIGRID SOLUTION METHOD

C. W. Oosterlee and P. Wesseling 1992 19 p
(Rept-92-48; ETN-93-93137) Copyright Avail: CASI HC A03/MF A01

The extension of a code to study flow problems around objects in two and three dimensions, with the use of an artificial interior boundary to solve single block discretization periodic boundary condition flow problems, is addressed. The steady flow in two dimensions around a circle and an ellipse is presented for a (relatively) low Reynolds number. The discretization, the adaptation of the existing multigrid solution algorithm to singular systems which appear in the smoothing algorithm, and steady flow results, are presented. ESA

N93-27939# Technische Univ., Delft (Netherlands). Dept. of Mechanical Engineering and Marine Technology.

NATURAL CONVECTION AROUND A SMOOTH CYLINDER AND A SPIRO TUBE: EXPERIMENTS AND CALCULATIONS Ph.D. Thesis

Liping Ma 1992 159 p
(ISBN-90-370-0072-X; ETN-93-93619) Copyright Avail: CASI HC A08/MF A02

A study on laminar natural convection around a smooth cylinder and a Spiro tube is described in terms of experiments as well as calculations. As a practical application of this study, the optimum design of the Spiro tube was also performed. An experimental set up was established, and the temperature distributions and the heat transfer around the smooth cylinder and the Spiro tube were measured. The measured data were used to verify the calculations. The calculations were carried out by means of the Galerkin finite element method. The governing equations, which originate from the related conservation principles, were solved in the fluid primitive variables. Two cases were distinguished in the calculations: the smooth cylinder and the Spiro tube in infinite space and within confining plates. As proved by the calculations, the confining plates have a strong effect on the heat transfer. The wires at the outside of the Spiro tube are complex in geometry. A special model was developed in the calculations to simulate their contribution to the flow and heat transfer. According to this model, the flow resistance and the heat transfer rate provided by the wires are approximated by drag forces and heat sources. The distributions of drag forces and heat source indicate where the wires have the maximum flow resistance and where the wires are effective in heat transfer. According to these distributions, improvement can be made in the design of the Spiro tube. An empirical formula was proposed, in order to conveniently calculate the heat transfer around the Spiro tube. Based on the experiments and the calculations, this formula relates the mean Nusselt number to the Rayleigh number as well as to various geometrical parameters of the Spiro tube. Then the optimum design of the Spiro tube was performed. The optimization predicts the best geometry for the heat transfer. This considerably reduces the manufacturing cost of the Spiro tube. ESA

N93-28069 Syracuse Univ., NY.

COLLECTIVE DYNAMICS IN DENSE FLUID MIXTURES Ph.D. Thesis

Supurna Sinha 1992 160 p
Avail: Univ. Microfilms Order No. DA9306991

This thesis deals with the short wavelength collective dynamics of dense binary fluid mixtures. The analysis shows that at the level of linearized generalized hydrodynamics, the longitudinal modes of the system separates essentially into two parts--one, involves the coupling of partial density fluctuations of the two species and the other involves coupling of longitudinal momentum and temperature fluctuations. We have shown that the coupling of longitudinal momentum and temperature fluctuations leads to an adequate description of sound propagation in such systems. In particular, we show that structural disorder controls the trapping of sound waves in dense mixtures. The coupling of the partial density fluctuations of the two species leads to a simple description of the partial dynamic structure factors. We find that our results are in agreement with the molecular dynamics simulations of soft sphere mixtures. The partial density fluctuations are the slowest decaying fluctuations on molecular length scales and it turns out that nonlinear coupling of these slow modes lead to important corrections to the long time behavior of the time correlation functions determining the shear viscosity in dense mixtures. Author

N93-28077# Universiteit Twente, Enschede (Netherlands). Dept. of Applied Mathematics.

WAVEPACK: BASIC CONCEPTS OF LINEAR WAVE PROPAGATION

E. vanGroesen, F. vanBeckum, and W. Djohan (Bandung Inst. of Tech., Indonesia.) 7 Aug. 1992 51 p Report contains floppy disk
(MEMO-1068; ETN-93-93850) Avail: CASI HC A04/MF A01

WAVEPACK is a software package under developement that is operated on PC's and designed to illustrate and calculate wave phenomena governed by linear and nonlinear partial differential equations. The aims are both instructional and research oriented, with emphasis on diagnostics of the phenomena. WAVEPACK1 illustrates in a didactic way basic concepts of linear wave propagation. The theory and a manual of the first part WAVPACK1a are presented, and such concepts as translation, monochromatic waves, dispersion, dispersion relation, phase and group velocity, are addressed. These concepts are illustrated in various ways: beats, wave packets, and centro-velocity (the velocity of the center of gravity of energy like densities). The software package WAVEPACK1a is operated through a user friendly menu driven interface. Initial data and coefficients in the equations can be varied, as well as the appearance and contents of the graphic display (wave forms at different times, mode dynamics, etc.). A help file and a short mathematical explanation file are available at any time. ESA

N93-28110# Technische Univ., Delft (Netherlands). Dept. of Civil Engineering.

WAVE PROPAGATION, LOCALISATION AND DISPERSION IN SOFTENING SOLIDS Ph.D. Thesis

Lambertus Johannes Sluys 1992 178 p Sponsored by Prins Maurits Laboratory TNO, Rijswijk, Netherlands

(ISBN-90-9005139-2; ETN-93-93593) Avail: CASI HC A09/MF A02

The development of models for the softening solid (metals, polymers, soils, concrete and rock) that admit localization of deformation while preserving well posedness of the initial value problem is addressed. This is essential for a proper computational modeling of failure without a spurious influence of the finite element discretization. Wave propagation models were considered, in which wave reflection in the localization zone and behavior of waves in the localization zone are important. Attention is confined to the response in wave propagation problems under impact loadings. The occurrence of string softening causes all further deformation to localize in small bands, which are often a precursor to failure. The basic deficiencies of the use of a strain softening model in the framework of a classical, rate independent continuum are discussed; and then the incorporation of extra or higher order terms in the continuum models, to solve the basic deficiencies of the classical continuum model for strain softening is suggested: the addition of viscous, or higher order time derivatives; the addition of higher order deformation gradients; and the use of a micro polar (Cosserat) continuum. ESA

N93-28149# Sandia National Labs., Albuquerque, NM.

FINITE ELEMENT METHODS FOR NON-NEWTONIAN FLOWS

D. K. Gartling Oct. 1992 84 p

(Contract DE-AC04-76DP-00789)

(DE93-006458; SAND-92-0886) Avail: CASI HC A05/MF A01

The application of the finite element method to problems in non-Newtonian fluid mechanics is described. The formulation of the basic equations is presented for both inelastic and viscoelastic constitutive models. Solution algorithms for treating the material nonlinearities associated with inelastic fluids are described; typical solution procedures for the implicit stress-rate equations of viscoelastic fluids are also presented. Methods for the simulation of various types of free-surface flows are also outlined. Simple example analyses are included for both types of fluid models. DOE

N93-28154# Universiteit Twente, Enschede (Netherlands). Dept. of Applied Mathematics.

QUASI-HOMOGENEOUS CRITICAL SWIRLING FLOWS IN EXPANDING PIPES

E. vanGroesen and B. W. vandeFliert Aug. 1992 23 p

(MEMO-1069; ETN-93-93851) Avail: CASI HC A03/MF A01

Time independent swirling flows in rotation symmetric pipes of constant and varying diameter are constructed using variational techniques. Critical flows in pipes of uniform cross section are found by extremizing the cross sectional energy at constrained value of the cross sectional helicity and the axial flow rate. Discrete classes of flows are found explicitly, parameterized by the radius and the value of the cross sectional helicity. Aprroximate flows in a slowly expanding pipe are constructed in a quasi homogeneous way as a succession in the axial direction of critical flows in uniform pipes. With the changing value of the radius, the value of the cross sectional helicity is adjusted to satisfy the correct energy conservation. The approximate flows have the property that the local energy density remains almost constant, while the local helicity density decreases for increasing radius. Solution branches can show the phenomenon of flow reversal at the central axis of the pipe: the axial velocity changes sign with increasing radius. ESA

N93-28205# Oesterreichisches Forschungszentrum Seibersdorf G.m.b.H., Vienna. Hauptabt. Energie- und Anlangentechnik.

STEADY HEAT TRANSFER IN A TUBE WITH TURBULENT FLOW [DER STATIONAERE WAERMEUEBERGANG BEI EINER TURBULENTEN ROHRSTROEMUNG]

Heinz Schmidl Jul. 1992 56 p In GERMAN

(OEFZS-4642; ETN-93-93453) Copyright Avail: CASI HC A04/MF A01

A two dimensional analysis of the dynamic behavior of heat transfer in a tube with turbulent flow was performed. To that end, a test setup with heat exchanger was built in which the steady state temperature distribution was investigated. The evaluation of these temperature profiles allows a check and if necessary, a new definition of several parameters desribed in the literature, such as the heat exchange parameters. The comparison of the results of the measurements with those of the energy equation gives the eddy diffusivity for heat transfer. ESA

N93-28236# Institute of Gas Technology, Chicago, IL.

DETERMINATION OF FLOW-REGIME BOUNDARIES FOR COHESIVE PARTICLES

T. M. Knowlton, J. G. Findlay, H. Arastoopour, and D. Gidaspow Oct. 1992 124 p Prepared in cooperation with Illinois Inst. of Tech., Chicago

(Contract DE-AC22-88PC-88951)

(DE93-011542; DOE/PC-88951/T2) Avail: CASI HC A06/MF A02

Cohesive particles (Geldart Group C powders) are fine particles generally less than 30 microns in size. Interparticle forces are large relative to inertial forces in these particles, and cause clumping, sticking, and channeling when attempts are made to fluidize them. These solids do not flow easily through pipes, and bridge extremely easily. The objectives of the work in this program were (1) to develop a hydrodynamic model which can be applied to cohesive solids, and (2) to obtain data in a large-scale (30-cm-diameter) riser to test the model. The work was divided into six tasks: Task 1. Preparation of a Project Work Plan; Task 2. Hydrodynamic Model Development; Task 3. Determination of Rheological Properties for Incorporation into the Model; Task 4. Small-Scale Flow Tests; Task 5. Large-Scale Flow Tests; and Task 6. Comparison of Model With Data. The work was conducted by the Institute of Gas Technology (IGT) in collaboration with the Illinois Institute of Technology (IIT). This work combined the expertise of IIT in model development, with the large-scale experimental capabilities of IGT. IIT researchers developed the hydrodynamic model in the program, while the large-scale data were generated by IGT. Following the preparation of the Project Work Plan in Task 1, work was started on the development of a two-dimensional hydrodynamic model to enable the behavior of cohesive solids in a dilute-phase riser to be simulated. In Task 2, two hydrodynamic models were developed based on the kinetic theory model of granular flow. The models were used to predict data presented in the literature, as well as data generated in Task 5 of this study. In Task 3, rheological data on cohesive oil shale with an average particle size of approximately 12 microns was obtained using a unique device called a cohetester. DOE

N93-28242# California Univ., San Diego, La Jolla. Office of Contract and Grant Administration.

STUDIES OF ORIGIN OF THREE-DIMENSIONALITY IN LAMINAR WAKES Final Technical Report, 1 Dec. 1989 - 31 Jan. 1993

Morteza Gharib 17 Feb. 1993 32 p

(Contract N00014-90-J-1314)

(AD-A262281) Avail: CASI HC A03/MF A01

Wind tunnel experiments, using hot-wire anemometry and smoke-wire flow visualization, were conducted to study the process of transition from laminar to turbulent flow of parallel and oblique vortex streets from circular cylinders. It was found that the origin and scale of three-dimensionality which appears at Reynolds numbers just below the transition from laminar to turbulent flow are dependent on the vortex shedding geometry in the near-wake. Oblique vortex streets develop large scale three-dimensional structures and undergo an early transition, i.e. at lower Reynolds numbers, when compared to parallel vortex streets. This is due to the presence of three-dimensionality in oblique wakes at pretransition Reynolds numbers, whereas parallel wakes remain laminar until the vortices themselves develop three-dimensional features. The downstream evolution of these two wake geometries from the primary Karman vortices to the far-wake vortical structures was also investigated. The far-wake structures are parallel to the cylinder axis for parallel shedding. For oblique shedding, these structures are initially parallel to the cylinder axis, but further downstream they develop a strong spanwise modulation whose wavelength is the spanwise distance between two consecutive Karman vortices of the same sign of vorticity. DTIC

N93-28252*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

MIXING AND TRANSIENT INTERFACE CONDENSATION OF A LIQUID HYDROGEN TANK

C. S. Lin (Analex Corp., Brook Park, OH.), M. M. Hasan, and T. W. Nyland Jun. 1993 18 p Proposed for presentation at the 29th Joint Propulsion Conference and Exhibit, Monterey, CA, 28-30 Jun. 1993; sponsored by AIAA, SAE, ASME, and ASEE
(RTOP 506-42-73)
(NASA-TM-106201; E-7910; NAS 1.15:106201; AIAA Paper 93-1968)
Avail: CASI HC A03/MF A01

Experiments were conducted to investigate the effect of axial jet-induced mixing on the pressure reduction of a thermally stratified liquid hydrogen tank. The tank was nearly cylindrical, having a volume of about 0.144 cu m with 0.559 m in diameter and 0.711 m long. A mixer/pump unit, which had a jet nozzle outlet of 0.0221 m in diameter was located 0.178 m from the tank bottom and was installed inside the tank to generate the axial jet mixing and tank fluid circulation. The liquid fill and jet flow rate ranged from 42 to 85 percent (by volume) and 0.409 to 2.43 cu m/hr, respectively. Mixing tests began with the tank pressure ranging from 187.5 to 238.5 kPa at which the thermal stratification results in 4.9 to 6.2 K liquid sub cooling. The mixing time and transient vapor condensation rate at the liquid-vapor interface are determined. Two mixing time correlations, based on the thermal equilibrium and pressure equilibrium, are developed. Both mixing time correlations are expressed as functions of system and buoyancy parameters and compared well with other experimental data. The steady state condensation rate correlation of Sonin et al. based on steam-water data is modified and expressed as a function of jet subcooling. The limited liquid hydrogen data of the present study shows that the modified steady state condensation rate correlation may be used to predict the transient condensation rate in a mixing process if the instantaneous values of jet sub cooling and turbulence intensity at the interface are employed.
Author (revised)

N93-28378# Phillips Lab., Kirtland AFB, NM.
HIGH STRAIN LAGRANGIAN HYDRODYNAMICS: A THREE DIMENSIONAL SPH CODE FOR DYNAMIC MATERIAL RESPONSE Final Report, Oct. 1991 - Sep. 1992
Firooz A. Allahdadi, Theodore C. Carney, Jim R. Hipp, Larry D. Libersky, and Albert G. Petschek Mar. 1993 22 p
(AD-A262798; AD-E201452; PL-TR-92-1054) Avail: CASI HC A03/MF A01

MAGI, a three-dimensional shock and material response code which is based on Smoothed Particle Hydrodynamics is described. Calculations are presented and compared with experimental results. The SPH method is unique in that it employs no spatial mesh. The absence of a grid leads to some nice features such as the ability to handle large distortions in a pure Lagrangian frame and a natural treatment of voids. Both of these features are important in the tracking of debris clouds produced by hypervelocity impact, a difficult problem for which Smoothed Particle Hydrodynamics seems ideally suited. It is believed this is the first application of SPH to the dynamics of elastic-plastic solid. DTIC

N93-28405# Rensselaer Polytechnic Inst., Troy, NY. Center for Multiphase Research.
AN EXPERIMENTAL STUDY OF A PLUNGING LIQUID JET INDUCED AIR CARRYUNDER AND DISPERSION Quarterly Report No. 9
F. Bonetto, D. A. Drew, and R. T. Lahey, Jr. 31 Mar. 1993 39 p
(Contract N00014-91-J-1271)
(AD-A262791) Avail: CASI HC A03/MF A01

A good understanding of the air carryunder and bubble dispersion process associated with a plunging liquid jet is vital if one is to be able to quantify such diverse phenomena as sea surface chemistry, the meteorological significance of breaking ocean waves (e.g., mitigation of the greenhouse effect due to the absorption of CO2 by the oceans), the performance of certain type of chemical reactors, and a number of other important maritime-related applications. The absorption of greenhouse gases into the ocean has been hypothesized to be highly dependent upon the air carryunder that occurs due to breaking waves. This process can be approximated with a plunging liquid jet. Moreover, the air entrainment process due to the breaking bow waves of surface ships may cause long (i.e., up to 5 km in length) wakes. Naturally, easily detectable wakes are undesirable for naval warships. In addition, the air carryunder that occurs at most hydraulic structures in rivers is primarily responsible for the large air/water mass transfer that is associated with these structures. Also, air entrainment plays an important role in the slug flow regime. In particular, the liquid film surrounding a Taylor bubble has a flow in the opposite direction from the Taylor bubble. This liquid film can be thought of as a plunging liquid jet that produces a surface depression in the rear part of the Taylor bubble.
DTIC

N93-28430# Lawrence Livermore National Lab., CA.
NOTES ON THE KIVA-2 SOFTWARE AND CHEMICALLY REACTIVE FLUID MECHANICS
M. J. Holst (Illinois Univ., Urbana.) Sep. 1992 48 p
(Contract W-7405-eng-48)
(DE93-008850; UCRL-ID-112019) Avail: CASI HC A03/MF A01

Working notes regarding the mechanics of chemically reactive fluids with sprays, and their numerical simulation with the KIVA-2 software are presented. KIVA-2 is a large FORTRAN program developed at Los Alamos National Laboratory for internal combustion engine simulation. It is our hope that these notes summarize some of the necessary background material in fluid mechanics and combustion, explain the numerical methods currently used in KIVA-2 and similar combustion codes, and provide an outline of the overall structure of KIVA-2 as a representative combustion program, in order to aid the researcher in the task of implementing KIVA-2 or a similar combustion code on a massively parallel computer. The notes are organized into three parts as follows. In Part 1, a brief introduction to continuum mechanics, to fluid mechanics, and to the mechanics of chemically reactive fluids with sprays is presented. In Part 2, a close look at the governing equations of KIVA-2 is taken, and the methods employed in the numerical solution of these equations is discussed. Some conclusions are drawn and some observations are made in Part 3. DOE

N93-28443# Institut National de Recherche d'Informatique et d'Automatique, Valbonne (France). Programme 6: Calcul Scientifique, Modelisation et Logiciels Numeriques.
MESH ADAPTION FOR COMPRESSIBLE FLOWS
Bernadette Palmerio (Nice Univ., France.) May 1992 20 p Presented at the ICFD Conference on Numerical Methods for Fluid Dynamics, Reading, United Kingdom, 7-10 Apr. 1992
(INRIA-RR-1683; ETN-93-93904) Avail: CASI HC A03/MF A01

Developments in mesh adaption for compressible viscous-inviscid flow simulation are described. One of the most challenging tasks is to capture efficiently thin layers such as boundary layers and mixing layers. Two important issues, the coupling between mesh and flow and the use of flat elements for stretching, are considered in the case of deformation mesh systems. For many applications, variable topology method (enrichment and coarsening, regeneration) proved to be efficient, on a static point of view or in an unstationary dynamical one. However, for viscous flows involving different type of layers, not only a static point of view is not sufficient since several (or even ten) static phases may be necessary to properly capture the existing layers, but also the cost constraints lead to apply very flat elements. Flat elements are shown to be easily handled if a mesh deformation is applied in one direction of the mesh topology (structured mesh); conversely, in variable topology methods, very flat elements are difficult or costly to obtain. Between these two standpoints, the capture of layers in arbitrary directions and on nonstructured meshes stays challenging. ESA

N93-26929*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
NTR PLUME MODELING
D. Byers, C.-H. Chung, and Robert M. Stubbs *In its* Nuclear Propulsion Technical Interchange Meeting, Volume 1 1993 p 453-460 (For primary document see N93-26908 10-20)
Avail: CASI HC A02/MF A04

N93-26930*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
COMPUTATIONAL FLUID DYNAMICS FOR NUCLEAR THERMAL PROPULSION
Robert M. Stubbs and Suk C. Kim *In its* Nuclear Propulsion Technical Interchange Meeting, Volume 1 1993 p 461-469 (For primary document see N93-26908 10-20)
Avail: CASI HC A02/MF A04

N93-27170 Tel-Aviv Univ. (Israel). Faculty of Exact Sciences.
SPURIOUS FREQUENCIES AS A RESULT OF NUMERICAL BOUNDARY TREATMENTS
S. Abarbanel *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 26-29 (For primary document see N93-27166 10-01)
Copyright Avail: Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel

N93-27190 Cornell Univ., Ithaca, NY. National Supercomputer Facility.
PARALLEL COMPUTING STRATEGIES FOR BLOCK MULTIGRID IMPLICIT SOLUTION OF THE EULER EQUATION
Yoram Yadlin and David A. Caughey *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 197-206 (For primary document see N93-27166 10-01)
Copyright Avail: Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel

N93-27219 Technion - Israel Inst. of Tech., Haifa. Faculty of Aerospace Engineering.
ON THE INTERACTIONS BETWEEN DETONATION WAVES AND SHOCK WAVES IN THE EXTERNAL PROPULSION METHOD FOR ACCELERATION OF PROJECTILES
Josef Rom and Gavriel Avital *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 439-445 Sponsored by V. P. R. - L. Kraus Research Fund and Asher Peled Memorial Fund (For primary document see N93-27166 10-01)
Copyright Avail: Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel

N93-27222 Case Western Reserve Univ., Cleveland, OH.
APPLICATION OF MOLECULAR DYNAMICS TO COMPUTATIONS OF SPATIAL DISTRIBUTIONS OF GAS STREAMS FROM A SOLID SURFACE
Isaac Greber, Harold Y. Wachman (Massachusetts Inst. of Tech., Cambridge.), and Greg Kass (Wright Research Development Center, Wright-Patterson AFB, OH.) *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 467-472 (For primary document see N93-27166 10-01)
Copyright Avail: Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel

N93-27430*# Institut fuer Theoretische Stroemungsmechanik, Goettingen (Germany).
ON THE ROLE OF SECONDARY INSTABILITIES IN LAMINAR-TURBULENT TRANSITION OF 2D AND 3D BOUNDARY LAYERS Abstract Only
Uwe Dallman, Thomas M. Fischer, Werner Koch, and Hans Bippes (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen, Germany.) *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 1 p (For primary document see N93-27427 10-02)
Avail: CASI HC A01/MF A04

N93-27433*# Arizona State Univ., Tempe. Dept. of Mechanical and Aerospace Engineering.
A COMPRESSIBLE NEAR-WALL TURBULENCE MODEL FOR BOUNDARY LAYER CALCULATIONS
R. M. C. So, H. S. Zhang, and Y. G. Lai *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 14 p (For primary document see N93-27427 10-02)
(Grant NAG1-1080)
Avail: CASI HC A03/MF A04

N93-27434*# Korea Advanced Inst. of Science and Technology, Seoul (Republic of Korea). Dept. of Mechanical Engineering.
ANALYSIS OF THE EFFECT OF INITIAL CONDITIONS ON THE INITIAL DEVELOPMENT OF A TURBULENT JET
Soong Ki Kim, Myung Kyoon Chung, and Ji Ryong Cho *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 6 p (For primary document see N93-27427 10-02)
Avail: CASI HC A02/MF A04

N93-27435*# California Univ., Davis. Dept. of Mechanical, Aeronautical and Materials Engineering.
THE INFLUENCE OF BULGES ON BOUNDARY-LAYER INSTABILITY Abstract Only
S. Elli and C. P. vanDam *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 1 p (For primary document see N93-27427 10-02)
Avail: CASI HC A01/MF A04

N93-27438*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
NUMERICAL MODELING OF RUNBACK WATER ON ICE PROTECTED AIRCRAFT SURFACES
Kamel M. Al-Khalil (National Academy of Sciences - National Research Council, Washington, DC.), Theo G. Keith, Jr. (Toledo Univ., OH.), and Kenneth J. DeWitt (Toledo Univ., OH.) *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 12 p (For primary document see N93-27427 10-02)
Avail: CASI HC A03/MF A04

N93-27451*# Cincinnati Univ., OH. Dept. of Aerospace Engineering and Engineering Mechanics.
INVESTIGATION OF FORCED UNSTEADY SEPARATED FLOWS USING VELOCITY-VORTICITY FORM OF NAVIER-STOKES EQUATIONS
K. N. Ghia, U. Ghia, and G. A. Osswald *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 10 p (For primary document see N93-27427 10-02)
Avail: CASI HC A02/MF A04

N93-27458*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
A UNIFIED APPROACH FOR NUMERICAL SIMULATION OF VISCOUS COMPRESSIBLE AND INCOMPRESSIBLE FLOWS OVER ADIABATIC AND ISOTHERMAL WALLS
M. Hafez (California Univ., Davis.), M. Soliman (California Univ., Davis.), and S. White *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 18 p (For primary document see N93-27427 10-02)
Avail: CASI HC A03/MF A04

N93-27461*# California Univ., Davis. Dept. of Mechanical and Aeronautical Engineering.
COMBINED FORCED AND FREE CONVECTION IN A CURVED DUCT
Clement G. Yam and Harry A. Dwyer *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 14 p (For primary document see N93-27427 10-02)
Avail: CASI HC A03/MF A04

N93-27463*# Cincinnati Univ., OH. Dept. of Aerospace Engineering and Engineering Mechanics.
ADAPTIVE MULTIGRID DOMAIN DECOMPOSITION SOLUTIONS FOR VISCOUS INTERACTING FLOWS
Stanley G. Rubin and Kumar Srinivasan *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 12 p (For primary document see N93-27427 10-02)
(Grants NAG3-397; AF-AFOSR-0096-90)
Avail: CASI HC A03/MF A04

N93-27465*# National Aerospace Lab., Amsterdam (Netherlands). Informatics Div.
A ROBUST QUASI-SIMULTANEOUS INTERACTION METHOD FOR A FULL POTENTIAL FLOW WITH A BOUNDARY LAYER WITH APPLICATION TO WING/BODY CONFIGURATIONS
A. J. vanderWees and J. vanMuijden *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 13 p (For primary document see N93-27427 10-02)
(Contract NIVR-01802-N)
Avail: CASI HC A03/MF A04

N93-27466*# Iowa Univ., Iowa City. Inst. of Hydraulic Research.
SHIP VISCOUS FLOW: A REPORT ON THE 1990 SSPA-IIHR WORKSHOP
Virendra C. Patel and Lars Larsson (Chalmers Univ. of Technology, Goeteborg, Sweden.) *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 15 p Sponsored in part by Swedish National Board for Technical Development (For primary document see N93-27427 10-02)
(Contract N00014-89-J-1670)
Avail: CASI HC A03/MF A04

N93-27467*# Centre d'Etudes et de Recherches, Toulouse (France).
THREE-DIMENSIONAL BOUNDARY LAYER CALCULATION BY A CHARACTERISTIC METHOD
R. Houdeville *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 11 p (For primary document see N93-27427 10-02)
Avail: CASI HC A03/MF A04

N93-27468*# Boeing Commercial Airplane Co., Seattle, WA.
TOWARDS INDUSTRIAL-STRENGTH NAVIER-STOKES CODES
Wen-Huei Jou, Laurence B. Wigton, and Steven R. Allmaras *In* California State Univ., The Fifth Symposium on Numerical and Physical Aspects of Aerodynamic Flows 1992 12 p (For primary document see N93-27427 10-02)
Avail: CASI HC A03/MF A04

35 INSTRUMENTATION AND PHOTOGRAPHY

Includes remote sensors; measuring instruments and gages; detectors; cameras and photographic supplies; and holography.

For aerial photography see *43 Earth Resources and Remote Sensing*. For related information see also *06 Aircraft Instrumentation*, and *19 Spacecraft Instrumentation*.

N93-26906*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
NEURAL NETWORKS FOR CALIBRATION TOMOGRAPHY
Arthur Decker Jun. 1993 10 p Proposed for presentation at the 1993 International Symposium on Optics, Imaging, and Instrumentation, San Diego, CA, 11-16 Jul. 1993; sponsored by Society of Photo-Optical Instrumentation Engineering
(RTOP 505-62-50)
(NASA-TM-106164; E-7857; NAS 1.15:106164) Avail: CASI HC A02/MF A01

Artificial neural networks are suitable for performing pattern-to-pattern calibrations. These calibrations are potentially useful for facilities operations in aeronautics, the control of optical alignment, and the like. Computed tomography is compared with neural net calibration tomography for estimating density from its x-ray transform. X-ray transforms are measured, for example, in diffuse-illumination, holographic interferometry of fluids. Computed tomography and neural net calibration tomography are shown to have comparable performance for a 10 degree viewing cone and 29 interferograms within that cone. The system of tomography discussed is proposed as a relevant test of neural networks and other parallel processors intended for using flow visualization data. Author (revised)

N93-27001*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
CALIBRATION OF A SHOCK WAVE POSITION SENSOR USING ARTIFICIAL NEURAL NETWORKS
Arthur J. Decker and Kenneth E. Weiland May 1993 20 p
(RTOP 505-62-50)
(NASA-TM-106138; E-7819; NAS 1.15:106138) Avail: CASI HC A03/MF A01

This report discusses the calibration of a shock wave position sensor. The position sensor works by using artificial neural networks to map cropped CCD frames of the shadows of the shock wave into the value of the shock wave position. This project was done as a tutorial demonstration of method and feasibility. It used a laboratory shadowgraph, nozzle, and commercial neural network package. The results were quite good, indicating that artificial neural networks can be used efficiently to automate the semi-quantitative applications of flow visualization. Author (revised)

N93-27021*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
THE DEVELOPMENT OF HYDROGEN SENSOR TECHNOLOGY AT NASA LEWIS RESEARCH CENTER
Gary W. Hunter, Philip G. Neudeck, G. D. Jefferson, G. C. Madzsar, C. C. Liu (Case Western Reserve Univ., Cleveland, OH.), and Q. H. Wu (Case Western Reserve Univ., Cleveland, OH.) May 1993 20 p Presented at the Fourth Annual Space System Health Management Technology Conference, Cincinnati, OH, 17-18 Nov. 1992; sponsored by AIAA
(RTOP 590-21-11)
(NASA-TM-106141; E-7773; NAS 1.15:106141) Avail: CASI HC A03/MF A01

The detection of hydrogen leaks in aerospace applications, especially those involving hydrogen fuel propulsion systems, is of extreme importance for reasons of reliability, safety, and economy. Motivated by leaks occurring in liquid hydrogen lines supplying the main engine of the Space Shuttle, NASA Lewis has initiated a program to develop point-contact hydrogen sensors which address the needs of aerospace applications. Several different approaches are being explored. They include the fabrication of PdAg Schottky diode structures, the characterization of PdCr as a hydrogen sensitive alloy, and the use of SiC as a semiconductor for hydrogen sensors. This paper discusses the motivation behind and present status of each of the major components of the NASA LeRC hydrogen sensor program. Author

N93-27027*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
FUZZY LOGIC PARTICLE TRACKING VELOCIMETRY
Mark P. Wernet Jun. 1993 10 p Proposed for presentation at the Optical Diagnostics in Fluid and Thermal Flow, San Diego, CA, 11-16 Jul. 1993; sponsored by Society of Photo-Optical Instrumentation Engineers
(RTOP 505-62-50)
(NASA-TM-106194; E-7900; NAS 1.15:106194) Avail: CASI HC A02/MF A01

Fuzzy logic has proven to be a simple and robust method for process control. Instead of requiring a complex model of the system, a user defined rule base is used to control the process. In this paper the principles of fuzzy logic control are applied to Particle Tracking Velocimetry (PTV). Two frames of digitally recorded, single exposure particle imagery are used as input. The fuzzy processor uses the local particle displacement information to determine the correct particle tracks. Fuzzy PTV is an improvement over traditional PTV techniques which typically require a sequence (greater than 2) of image frames for accurately tracking particles. The fuzzy processor executes in software on a PC without the use of specialized array or fuzzy logic processors. A pair of sample input images with roughly 300 particle images each, results in more than 200 velocity vectors in under 8 seconds of processing time. Author (revised)

N93-27625# Sandia National Labs., Albuquerque, NM.
FIBER-OPTIC SHOCK POSITION SENSOR
J. D. Weiss Mar. 1993 17 p
(Contract DE-AC04-76DP-00789)
(DE93-009607; SAND-93-0261) Avail: CASI HC A03/MF A01

This report describes work performed for the development of a fiber-optic shock position sensor used to measure the location of a shock front in the neighborhood of a nuclear explosion. Such a measurement would provide a hydrodynamic determination of nuclear yield. The original proposal was prompted by the Defense Nuclear Agency's interest in replacing as many electrical sensors as possible with their optical counterparts for the verification of a treaty limiting the yield of a nuclear device used in underground testing. Immunity to electromagnetic pulse is the reason for the agency's interest; unlike electrical sensors and their associated cabling, fiber-optic systems do not transmit to the outside world noise pulses from the device containing secret information. DOE

N93-27661# Air Force Inst. of Tech., Wright-Patterson AFB, OH.
SELF-REFERENCED SPECKLE HOLOGRAPHY (SRSH) IMAGE RECONSTRUCTION PERFORMANCE M.S. Thesis

John R. Devey Mar. 1993 76 p LIMITED REPRODUCIBILITY: More than 20% of this document may be affected by microfiche qualaity
(AD-A262487; AFIT/GEO/ENG/93M-01) Avail: CASI HC A05/MF A01

The Speckle Holography technique uses a series of short exposure images and associated wave front sensor measurements to reconstruct astronomical images. The reconstruction technique effectively boosts the amplitude of high spatial frequencies to allow for finer resolution of astronomical objects. A simulation package that calculates the optical transfer function (OTF) of a telescopic system was previously developed for the Phillips Laboratory. This software was modified slightly to provide the Speckle Holography system transfer function (STF) for a telescopic system under varying seeing conditions. DTIC

N93-27875# Technische Univ., Delft (Netherlands).
QUANTITATIVE HIGH-RESOLUTION ELECTRON MICROSCOPY AND HOLOGRAPHY Ph.D. Thesis
Wilhelmus Johannes deRuijter 1992 161 p
(Grants DMR-86-11609; DMR-89-13384)
(ISBN-90-6275-752-9/CIP; ETN-93-93601) Copyright Avail: CASI HC A08/MF A02

A thesis compiled from a collection of five papers on automated electron microscopy, quantitative high resolution electron microscopy, and holography, for research concentrating on the transmission electron microscope used for high resolution imaging, is presented. The following are described with detailed discussion and conclusions: methods to measure properties of slow scan CCD (Charge Coupled Device) cameras; quantification of high resolution lattice images; detection limits in quantitative off-axis electron hologrpahy; exit-surface wave reconstruction by means of a focal series; and practical autoalignment of transmission electron microscopes. The results are discussed in a broad context and anticipated developments are presented. ESA

N93-27950# Naval Research Lab., Washington, DC.
NEW RESULTS AND APPLICATIONS FOR THE QUASIOPTICAL GYROTRON Interim Report
A. W. Fliflet, R. P. Fischer, and W. M. Manheimer 26 Feb. 1993 50 p
(AD-A261961; NRL/MR/6793-93-7183) Avail: CASI HC A03/MF A01

The quasioptical gyrotron (QOG), which features an open resonator formed by a pair of spherical mirrors instead of the conventional gyrotron waveguide cavity, has been under development at the U.S. Naval Research Laboratory as a tunable high power millimeterwave source for tokamak plasma heating, advanced radars, and power beaming. In the free running oscillator configuration, the QOG has produced a peak power of 6OOkW at a frequency of 120GHZ, and a peak efficiency of 12% at 200kW. Results have recently been obtained for a quasioptical gyroklystron (QOGK) realized by the addition of an open-mirror prebunching resonator driven by an 85GHz, 1.5kW Extended Interaction Oscillator. Efficiency enhancement by mode priming has been investigated, and efficiencies up to 19% have been obtained by increasing the detuning of the operating mode. An overall efficiency of 30% was obtained by the addition of a simple depressed collector. The high circulating power in the QOG resonator is currently being considered for use as an electromagnetic wiggler for compact IR free-electron lasers. The QOG is also promising as a source for an active sensor of upper atmosphere trace impurities. DTIC

N93-28009# Sandia National Labs., Albuquerque, NM.
WIDE RANGE H2 SENSOR USING CATALYTIC ALLOYS
R. C. Hughes, R. J. Buss, S. W. Reynolds, M. W. Jenkins, and J. L. Rodriguez 1992 9 p Presented at the Chemical Sensor Symposium, Honolulu, HI, 16-21 May 1993
(Contract DE-AC04-76DP-00789)
(DE93-007591; SAND-92-2382C; CONF-9305124-1) Avail: CASI HC A02/MF A01

A new Wide Range Hydrogen Sensor fabricated on a silicon chip is described. A single die measuring 4 mm by 4 mm has four different kinds of hydrogen sensors, a heater and a temperature-measuring thin metal film. Chemiresistors made from thin films of a Pd/Ni alloy give an accurate measure of hydrogen concentrations from 0.1 to 100%, while Metal-Insulator-Silicon (MIS) capacitors are used for hydrogen concentrations down to about 1 ppM. A microprocessor controlled circuit is described that combines temperature control and signal processing. DOE

N93-28053*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
STATUS OF THE FIBER OPTIC CONTROL SYSTEM INTEGRATION (FOCSI) PROGRAM
Robert J. Baumbick May 1993 17 p
(RTOP 505-62-50)
(NASA-TM-106151; E-7832; NAS 1.15:106151) Avail: CASI HC A03/MF A01

This report presents a discussion of the progress made in the NASA/NAVY Fiber Optic Control System Integration (FOCSI) program. This program will culminate in open-loop flight tests of passive optical sensors and associated electro-optics on an F-18 aircraft. Currently, the program is in the final stages of hardware fabrication and environmental testing of the passive optical sensors and electro-optics. This program is a foundation for future Fly-by-Light (FBL) programs. The term Fly-by-Light is used to describe the utilization of passive optical sensors and fiber optic data links for monitoring and control of aircraft in which sensor and actuation signals are transmitted optically. The benefits of this technology for advanced aircraft include the following: improved reliability and reduced certification cost due to greater immunity to EME (electromagnetic effects); reduced harness volume and weight; elimination of short circuits and sparking in wiring due to insulation deterioration; lower maintenance costs (fewer components); greater flexibility in data bus protocol and architecture; absence of ground loops; and higher operating temperatures for electrically passive optical sensors. Author (revised)

N93-28160# Sandia National Labs., Albuquerque, NM.
AN ULTRASONIC SENSOR CONTROLLER FOR MAPPING AND SERVO CONTROL IN ROBOTIC SYSTEMS
W. D. Drotning and P. Garcia, Jr. Mar. 1993 37 p
(Contract DE-AC04-76DP-00789)
(DE93-009605; SAND-92-0887) Avail: CASI HC A03/MF A01

An ultrasonic sensor controller has been developed and applied in a variety of robotic systems for operation in hazardous environments. The controller consists of hardware and software that control multiple ultrasonic range sensors and provide workspace information to robot controllers for rapid, safe, and reliable operation in hazardous and remote environments. The hardware consists of a programmable multichannel controller that resides on a VMEbus for high speed communication to a multiprocessor architecture. The sensor controller has been used in a number of applications, which include providing high precision range information for proximity servo control of robots, and performing surface and obstacle mapping functions for safe path planning of robots in unstructured environments. DOE

N93-28322*# National Aeronautics and Space Administration. Pasadena Office, CA.
CORRECTION-FREE PYROMETRY IN RADIANT WALL FURNACES Patent Application
Andrew S. W. Thomas, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) 30 Mar. 1993 22 p
(Contract NAS7-918)
(NASA-Case-NPO-18655-1-CU; NAS 1.71:NPO-18655-1-CU; US-Patent-Appl-SN-044449) Avail: CASI HC A03/MF A01

A specular, spherical, or near-spherical target is located within a furnace having inner walls and a viewing window. A pyrometer located outside the furnace 'views' the target through pyrometer optics and the window, and is so positioned that its detector sees only the image of the viewing window on the target. Since this image is free of any image of the furnace walls, it is free from wall radiance, and correction-free target radiance is obtained. The pyrometer location is determined through a nonparaxial optical analysis employing differential optical ray tracing methods to derive a series of exact relations for the image location. NASA

N93-28373# Sandia National Labs., Albuquerque, NM.
MODAL TESTING USING A FULL INSTRUMENTATION TECHNIQUE
Larry Dorrell 1993 8 p Presented at the 39th International Instrumentation Symposium, Albuquerque, NM, 2-6 May 1993
(Contract DE-AC04-76DP-00789)
(DE93-009635; SAND-93-0451C; CONF-930561-2) Avail: CASI HC A02/MF A01

The Modal Group at Sandia National Laboratories performs a variety of

tests on structures ranging from weapons systems to wind turbines. The desired number of data channels for these tests has increased significantly over the past several years. Tests requiring large numbers of data channels makes roving, accelerometers impractical and inefficient. The Modal Lab has implemented a method in which the test unit is fully instrumented before any data measurements are taken. This method uses a 16 channel data acquisition system and a mechanical switching setup to access each bank of accelerometers. A data base containing all transducer sensitivities, location numbers, and coordinate information is resident on the system enabling quick updates for each data set as it is patched into the system. This method has reduced test time considerably and is easily customized to accommodate data acquisition systems with larger channel capabilities.
DOE

N93-27900*# Massachusetts Inst. of Tech., Cambridge. Space Engineering Research Center.
SENSOR AND ACTUATOR TECHNOLOGY DEVELOPMENT
Eric Anderson and Nesbitt W. Hagood *In its* Controlled Structures Technology Steering Committee Workshop 1992 19 p (For primary document see N93-27888 10-39)
Avail: CASI HC A03/MF A03

36 LASERS AND MASERS

Includes parametric amplifiers.
For related information see also *76 Solid-State Physics.*

N93-26613# California Univ., Berkeley. Lawrence Berkeley Lab.
EXPERIMENT AND SIMULATION OF HOLE-COUPLED RESONATOR MODES WITH A CW HeNe LASER
W. P. Leemans, M. Xie, J. A. Edighoffer, E. Wallace, K. J. Kim, and S. Chattopadhyay Aug. 1992 15 p Presented at the 14th International Free Electron Laser Conference, Kobe, Japan, 23-28 Aug. 1992
(Contract DE-AC03-76SF-00098)
(DE93-007729; LBL-32285; ESG-189; CONF-9208142-19) Avail: CASI HC A03/MF A01

The Infrared Free Electron Laser (IRFEL) for the proposed Chemical Dynamics Laboratory at Lawrence Berkeley Laboratory will operate from 3-50 microns and use all-metal optics. This choice of optics allows for broad tuning and has excellent power-handling capabilities. A hole-coupling approach for the optical resonator was adopted after extensive computer simulations verified that it fully met the design requirements. To bench-test the simulations we have carried out a scaled cavity experiment utilizing a visible (632.8 nm) continuous wave (CW) HeNe laser. Two cases have been studied: (1) a Gaussian near-concentric symmetric resonator; and (2) a hole-coupled resonator with degenerate higher order modes. The simple geometry of the former case allows for a direct comparison with analytical theory and is useful for bench marking the diagnostic equipment. Since mode degeneracy should be avoided for good operation of an FEL, gaining an understanding of the latter case is important. Furthermore, it provides a good test case for evaluating the code performance. After discussing the theoretical model used in the simulations, we describe the cavity parameters and the experimental set-up. We proceed by comparing, for both case (1) and (2), the experimental results with theoretical predictions and simulations. This is followed by the summary and conclusions of these experiments.
DOE

N93-27036*# Sirius Group, Peabody, MA.
SYSTEMS ANALYSIS ON LASER BEAMED POWER Final Report, 5 May - 30 Oct. 1992
Glenn W. Zeiders, Jr. Apr. 1993 46 p
(NASA Order H-11986-D)
(NASA-CR-193206; NAS 1.26:193206) Avail: CASI HC A03/MF A01

The NASA SELENE power beaming program is intended to supply cost-effective power to space assets via Earth-based lasers and active optics systems. Key elements of the program are analyzed, the overall effort is reviewed, and recommendations are presented. Author

N93-27120# Rochester Univ., NY. Lab. for Laser Energetics.
[SUMMARY OF PROGRESS IN LASER FUSION; ADVANCED TECHNOLOGY DEVELOPMENTS: NATIONAL LASER USERS FACILITY NEWS; AND A LASER SYSTEM REPORT] Final Annual Report, 1 Oct. 1991 - 30 Sep. 1992
Jan. 1993 243 p
(Contract DE-FC03-85DP-40200)
(DE93-009054; DOE/DP-40200/240) Avail: CASI HC A11/MF A03

This is an annual report covering research progress on laser fusion and the OMEGA Upgrade design and development. In laser fusion, line-spectroscopy methods were demonstrated to be useful in diagnosing the core temperature and densities of polymer-shell targets; a theoretical analysis of nonlocal heat transport effects on filamentation of light in plasmas confirms that the principle mechanism driving filamentation is kinetic thermal rather than ponderomotive; a new method (spatial beam deflection) to produce laser pulses of arbitrary shape was developed; laser-plasma x-ray emission was measured using photodiode arrays; experiments on long-scale-length plasmas have shown that smoothing by spectral dispersion has proven effective in reducing Raman scattering; a method for increasing the gas-retention time of polymer shell targets was developed by overcoating them with aluminum. Experiments relating to the OMEGA Upgrade are described.
DOE

N93-27153*# Schwartz Electro-Optics, Inc., Concord, MA.
DIODE-PUMPED LASER ALTIMETER Final Report, 1 Jun. 1990 - 31 Mar. 1993
D. Welford and Y. Isyanova Jun. 1993 98 p Original contains color illustrations
(Contract NAS5-30882)
(NASA-CR-193166; NAS 1.26:193166) Avail: CASI HC A05/MF A02; 12 functional color pages

TEM(sub 00)-mode output energies up to 22.5 mJ with 23 percent slope efficiencies were generated at 1.064 microns in a diode-laser pumped Nd:YAG laser using a transverse-pumping geometry. 1.32-micron performance was equally impressive at 10.2 mJ output energy with 15 percent slope efficiency. The same pumping geometry was successfully carried forward to several complex Q-switched laser resonator designs with no noticeable degradation of beam quality. Output beam profiles were consistently shown to have greater than 90 percent correlation with the ideal TEM(sub 00)-order Gaussian profile. A comparison study on pulse-reflection-mode (PRM), pulse-transmission-mode (PTM), and passive Q-switching techniques was undertaken. The PRM Q-switched laser generated 8.3 mJ pulses with durations as short as 10 ns. The PTM Q-switch laser generated 5 mJ pulses with durations as short as 5 ns. The passively Q-switched laser generated 5 mJ pulses with durations as short as 2.4 ns. Frequency doubling of both 1.064 microns and 1.32 microns with conversion efficiencies of 56 percent in lithium triborate and 10 percent in rubidium titanyl arsenate, respectively, was shown. Sum-frequency generation of the 1.064 microns and 1.32 microns radiations was demonstrated in KTP to generate 1.1 mJ of 0.589 micron output with 11.5 percent conversion efficiency. Author (revised)

N93-27249*# Maryland Univ., College Park. Inst. for Physical Science and Technology.
DEVELOPMENT AND APPLICATIONS OF TUNABLE, NARROW BAND LASERS AND STIMULATED RAMAN SCATTERING DEVICES FOR ATMOSPHERIC LIDAR Final Report
Thomas D. Wilkerson Jun. 1993 41 p Original contains color illustrations
(Contract NCC1-25)
(NASA-CR-193160; NAS 1.26:193160; TN-BN-1150) Avail: CASI HC A03/MF A01; 2 functional color pages

The main thrust of the program was the study of stimulated Raman processes for application to atmospheric lidar measurements. This has involved the development of tunable lasers, the detailed study of stimulated Raman scattering, and the use of the Raman-shifted light for new measurements of molecular line strengths and line widths. The principal spectral region explored in this work was the visible and near-IR wavelengths between 500 nm and 1.5 microns. Recent alexandrite ring laser experiments are reported. The experiments involved diode injection-locking, Raman shifting, and frequency-doubling. The experiments succeeded in producing

tunable light at 577 and 937 nm with line widths in the range 80-160 MHz. Author (revised)

N93-27656# Texas Univ. at Dallas, Richardson. Center for Quantum Electronics.
PROOF OF THE FEASIBILITY OF COHERENT AND INCOHERENT SCHEMES FOR PUMPING A GAMMA RAY LASER Annual Letter Report, 24 Dec. 1991 - 23 Dec. 1992
C. B. Collins 31 Dec. 1992 166 p
(Contract N00014-90-K-2001)
(AD-A262421; GRL/9201) Avail: CASI HC A08/MF A02

The most productive approaches to the problem of the gamma-ray laser have focused upon upconversion techniques in which metastable nuclei are pumped with long wavelength radiation. At the nuclear level the storage of energy can approach tera-Joules 10(exp 12)J per liter for thousands of years. However, any plan to use such a resource for a gamma-ray laser poses problems of a broad interdisciplinary nature requiring the fusion of concepts taken from relatively unrelated fields of physics. Our research group has described several means through which this energy might be coupled to radiation fields with cross sections for stimulated emission that could reach 10(exp -17) sq cm. Such a stimulated release could lead to output powers as great as 3 X 10(exp 21) Watts/liter. Since 1978 we have pursued an approach for the upconversion of longer wavelength radiation incident upon isomeric nuclear populations that can avoid many of the difficulties encountered with traditional concepts of single photon pumping. Experiments have confirmed the general theory and have indicated that a gamma-ray laser is feasible if the right combination of energy levels and branching ratios exists in some real material. Of the 1,886 distinguishable nuclear materials, the present state-of-the-art has been adequate to identify 29 first-class candidates. DTIC

N93-28132*# National Aeronautics and Space Administration. Pasadena Office, CA.
BURST-BY-BURST LASER FREQUENCY MONITOR Patent Application
Carlos Esproles, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) 1 Feb. 1993 12 p
(Contract NAS7-918)
(NASA-Case-NPO-18596-1-CU; NAS 1.71:NPO-18596-1-CU; US-Patent-Appl-SN-023252) Avail: CASI HC A03/MF A01

The invention is a system for real-time frequency monitoring and display of an RF burst where the burst frequency is analyzed and displayed on a burst-by-burst basis in order to allow for frequency control. Although the invention was made for monitoring the laser frequency of a LIDAR system, it has other applications where realtime monitoring is required. The novelty of the invention resides in the use of a counter that is reset at the beginning of each unit time of monitoring and then gated for a unit of time. The invention also has an LED bar graph for displaying the measure of frequency at the end of each unit time in either a bar length mode or a moving dot mode. In the latter mode, the operator makes necessary adjustments to maintain the dot at the center of the bar graph. NASA

N93-28230# Lawrence Livermore National Lab., CA.
THERMAL MANAGEMENT IN GAS COOLED SOLID STATE LASER DISK AMPLIFIERS
S. B. Sutton, G. F. Albrecht, H. F. Robey, and B. L. Freitas 14 Apr. 1992 27 p Presented at the 23rd AIAA Plasma Dynamics and Lasers Conference, Nashville, TN, 6-8 Jul. 1992
(Contract W-7405-eng-48)
(DE93-009241; UCRL-JC-109280; CONF-9207111-3) Avail: CASI HC A03/MF A01

The technical issues associated with the cooling of large aperture, average power, solid-state laser disk amplifiers are addressed. The heat transfer requirements, their effect on optical distortion in the laser slabs and optical losses in the cooling stream, and the system efficiency penalty associated with the cooling flow are discussed. It is shown that it is possible to economically cool an average power, solid-state disk amplifier in such a manner that cooling related optical distortions and flow induced optical losses are tolerable. DOE

N93-28314# Brookhaven National Lab., Upton, NY.
AN ANALYSIS OF THE SATURATION OF A HIGH GAIN FEL
R. L. Gluckstern (Maryland Univ., College Park.), Hiromi Okamoto (Maryland Univ., College Park.), and S. Krinsky Dec. 1992 52 p
(Contract DE-AC02-76CH-00016)
(DE93-007276; BNL-48495) Avail: CASI HC A04/MF A01

We study the saturated state of an untapered free electron laser in the Compton regime, arising after exponential amplification of an initial low level of radiation by an initially monoenergetic, unbunched electron beam. The saturated state of the FEL is described by oscillations about an equilibrium state. Using the two invariants of the motion, and certain assumptions motivated by computer simulations, we provide approximate analytic descriptions of the radiation field and electron distribution in the saturation regime. We first consider a one-dimensional approximation, and later extend our approach to treat an electron beam of finite radial extent. Of note is a result on the radiated power in the case of an electron beam with small radius. DOE

N93-28333# Argonne National Lab., IL.
LASER COOLING OF A STORED ION BEAM: A FIRST STEP TOWARDS CRYSTALLINE BEAMS Ph.D. Thesis
J. S. Hangst Sep. 1992 124 p
(Contract W-31-109-eng-38)
(DE93-010301; ANL/PHY-93/1) Avail: CASI HC A06/MF A02

This report discusses: a brief introduction to storage rings; crystalline beams; laser cooling of ion beams; description of astrid-the experimental setup; first experiments with lithium 7 ion beam; experiments with erbium 166 ion beams; further experiments with lithium 7 ion beams; beam dynamics, laser cooling, and crystalline beams in astrid; and possibilities for further study in astrid. DOE

N93-28355# Brookhaven National Lab., Upton, NY.
ULTRAVIOLET FREE-ELECTRON LASER (UV FEL) FACILITY AT BROOKHAVEN NATIONAL LABORATORY
E. D. Johnson and J. C. Sutherland 1992 16 p Presented at the 4th International Conference on Biophysics and Synchrotron Radiation, Tsukuba, Japan, 30 Aug. - 5 Sep. 1992
(Contract DE-AC02-76CH-00016)
(DE93-007274; BNL-48343; CONF-920821-2; BIO-4693) Avail: CASI HC A03/MF A01

The proposal for an Ultraviolet Free-Electron Laser Facility (UV-FEL) grew from the realization that neither existing lasers or synchrotrons, nor the third generation synchrotron radiation sources now under construction address all of the needs of scientists interested in the ultraviolet region of the spectrum, particularly with respect to the combination of continuous wavelength selection, high peak power, and short pulse duration. Several workshops have been held at BNL and elsewhere which explored applications and source requirements in the 5 to 30 eV range. A critical requirement is for very high peak power and short wavelength, especially for applications in chemical physics and non-linear optics. The need for wavelength tuning with the ease and agility to which synchrotron radiation users have become accustomed has also been strongly emphasized. With these initial parameters in mind, the accelerator physics staff set about devising ways to produce this radiation. Their design is for an FEL that has unique characteristics both in terms of possible applications, and in the range of radiation it could produce. In addition, the proposed location of the UV-FEL adjacent to the NSLS means that pump-probe experiments involving radiation from both sources will be possible. Each successive design has been reviewed in consultation with potential users in an iterative process to arrive at the present proposal design. DOE

N93-28365# Kentucky Univ., Lexington. Dept. of Chemistry.
LASER SPECTROSCOPY AND DYNAMICS OF TRANSIENT SPECIES Progress Report, 1 Jun. 1992 - 31 May 1993
Dennis J. Clouthier Feb. 1993 4 p
(Contract DE-FG05-86ER-13544)
(DE93-011265; DOE/ER-13544/T4) Avail: CASI HC A01/MF A01

Work on sub-Doppler spectroscopy of thioformaldehyde is nearing completion; the sub-Doppler structure in the H2CS spectrum correlates with previous observations of anomalously long fluorescence lifetimes and reduced quantum yields of fluorescence under collision-free conditions. Singlet-triplet perturbations are large and occur haphazardly when levels in the two states are near-coincidence. High-resolution FTIR spectra of many bands of HCOCl and DCOCl have been recorded. Laser fluorescence on

formic acid is being studied. Reactive jet spectroscopy is being used to produce new reactive intermediates in F2/Ar gas streams. Preliminary experiments are underway in S3 and S4 systems. DOE

N93-28369# Los Alamos National Lab., NM.
SUB-NANOSECOND OPTICAL DIAGNOSTICS OF LASER-MATERIAL INTERACTION AND DYNAMIC MICROSTRUCTURE OF MATERIALS
D. L. Paisley and D. B. Stahl 1993 10 p Presented at the 20th International Congress on High Speed Photography and Photonics, Victoria, British Columbia
(Contract W-7405-eng-36)
(DE93-008702; LA-UR-93-557; CONF-9209188-9) Avail: CASI HC A02/MF A01

Several optical diagnostic techniques are used to evaluate the dynamic response of materials to intense dynamic loading and unloading, high stress and strain, and pressure. Velocity interferometry and electric streak photography, each with sub-nanosecond time resolution, are used to record dynamic material response. Laser-launched flat plates are accelerated to 10(exp 12) m/s(sup 2) with terminal velocities greater than 5 km/s. By impacting these plates into target samples, high strain rates (10(exp 8)/sec) and pressures greater than 100 GPa were generated for a duration of 0.8-5 nanoseconds. The efficacy and limitations of each technique are detailed and applications to other fields discussed. DTIC

N93-28451# Lawrence Livermore National Lab., CA.
THERMAL ANALYSIS OF TRANSMISSIVE ELEMENTS IN HIGH AVERAGE POWER LASER BEAM DELIVERY SYSTEMS
S. J. Cohen, R. E. English, Jr., C. J. Stolz, and J. R. Taylor Jul. 1992 10 p Presented at the Society of Photo-Optical Instrumentation Engineers International Symposium on Optical Applied Science and Engineering, San Diego, CA, 19-24 Jul. 1992
(Contract W-7405-eng-48)
(DE93-009235; UCRL-JC-110937; CONF-920792-48) Avail: CASI HC A02/MF A01

We describe a computer code that aids in the thermal, structural, and optical analysis of laser optical systems. Inputs to the computer model include energy absorption by coatings and substrates, thermal diffusion, expansion, and heat removal parameters. The program performs steady-state thermal and structural analyses based on geometrical ray traces through the optical system. We show examples to illustrate how this capability can assist in the optical system design process. DOE

N93-26936*# Los Alamos National Lab., NM. Chemical and Laser Sciences Div.
LASER DIAGNOSTICS FOR NTP FUEL CORROSION STUDIES
Paul J. Wantuck, D. P. Butt, and A. D. Sappey *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 1 1993 p 521-533 (For primary document see N93-26908 10-20)
Avail: CASI HC A03/MF A04

N93-27328*# Calspan Corp., Arnold AFS, TN. AEDC Div.
USING HARMONIC OSCILLATORS TO DETERMINE THE SPOT SIZE OF HERMITE-GAUSSIAN LASER BEAMS
Sidney L. Steely *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 155-170 (For primary document see N93-27311 10-74)
Avail: CASI HC A03/MF A04

37 MECHANICAL ENGINEERING

Includes auxiliary systems (nonpower); machine elements and processes; and mechanical equipment.

N93-26665# Argonne National Lab., IL. Energy Systems Div.
SURVEY OF FOREIGN MAGLEV SYSTEMS
J. L. He, D. M. Rote, and H. T. Coffey Jul. 1992 86 p
(Contract W-31-109-eng-38)
(DE93-008495; ANL/ESD-17) Avail: CASI HC A05/MF A01

Magnetic levitation (maglev) transportation systems represent an innovative technology that promises to provide pollution-free, contact-free, high-speed ground transportation for the twenty-first century. Great interest in maglev systems has been developing in the United States over the past two years under the auspices of the US National Maglev Initiative. The objective of the survey presented in this report is to provide the US maglev community with information on various maglev concepts that were developed in foreign countries over the past two decades. The main maglev systems included in the survey are the German Transrapid series and the M-Bahn, the Japanese HSST and MLU series, and the British Birmingham. Each maglev system is introduced and discussed according to its type, historical development, unique features, current status, and future prospects. Advantages and disadvantages of each system are briefly noted. DOE

N93-27037*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
CONTACT STRESS ANALYSIS OF SPIRAL BEVEL GEARS USING NONLINEAR FINITE ELEMENT STATIC ANALYSIS
G. D. Bibel (North Dakota Univ., Grand Forks.), A. Kumar (Akron Univ., OH.), S. Reddy (Akron Univ., OH.), and R. Handschuh (Army Research Lab., Cleveland, OH.) May 1993 12 p Presented at the 29th Joint Propulsion Conference and Exhibit, Monterey, CA, 28-30 Jun. 1993; cosponsored by AIAA, SAE, ASME, and ASEE Prepared in cooperation with Army Research Lab., Adelphi, MD
(RTOP 505-62-10; DA Proj. 1L1-62211-A-47-A)
(NASA-TM-106176; E-7876; NAS 1.15:106176; ARL-TR-158; AIAA Paper 93-2296) Avail: CASI HC A03/MF A01

A procedure is presented for performing three-dimensional stress analysis of spiral bevel gears in mesh using the finite element method. The procedure involves generating a finite element model by solving equations that identify tooth surface coordinates. Coordinate transformations are used to orientate the gear and pinion for gear meshing. Contact boundary conditions are simulated with gap elements. A solution technique for correct orientation of the gap elements is given. Example models and results are presented. Author

N93-27069*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
FAULT DETECTION OF HELICOPTER GEARBOXES USING THE MULTI-VALUED INFLUENCE MATRIX METHOD
Hsinyung Chin (Massachusetts Univ., Amherst.), Kourosh Danai (Massachusetts Univ., Amherst.), and David G. Lewicki Apr. 1993 32 p
(DA Proj. 1L1-62211-A-47-A; RTOP 505-63-36)
(NASA-TM-106100; E-7742; NAS 1.15:106100; AVSCOM-TR-92-C-015)
Avail: CASI HC A03/MF A01

In this paper we investigate the effectiveness of a pattern classifying fault detection system that is designed to cope with the variability of fault signatures inherent in helicopter gearboxes. For detection, the measurements are monitored on-line and flagged upon the detection of abnormalities, so that they can be attributed to a faulty or normal case. As such, the detection system is composed of two components, a quantization matrix to flag the measurements, and a multi-valued influence matrix (MVIM) that represents the behavior of measurements during normal operation and at fault instances. Both the quantization matrix and influence matrix are tuned during a training session so as to minimize the error in detection. To demonstrate the effectiveness of this detection system, it was applied to vibration measurements collected from a helicopter gearbox during normal operation and at various fault instances. The results indicate that the MVIM method provides excellent results when the full range of faults effects on the measurements are included in the training set. Author

N93-27074*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
AN ANALYSIS OF GEAR FAULT DETECTION METHODS AS APPLIED TO PITTING FATIGUE FAILURE DATA
J. J. Zakrajsek, D. P. Townsend, and H. J. Decker Jan. 1993 12 p Presented at the 47th Mechanical Failure Prevention Group, Virginia Beach, VA, 13-15 Apr. 1993 Prepared in cooperation with Army Aviation Systems Command, Cleveland, OH
(RTOP 505-62-10)
(NASA-TM-105950; E-7470; NAS 1.15:105950; AVSCOM-92-C-035) Avail: CASI HC A03/MF A01

The application of gear fault prediction techniques to experimental data is examined. A single mesh spur gear fatigue rig was used to produce naturally occurring faults on a number of test gear sets. Gear tooth surface

pitting was the primary failure mode for a majority of the test runs. The damage ranged from moderate pitting on two teeth in one test to spalling on several teeth in another test. Previously published failure prediction techniques were applied to the data as it was acquired to provide a means of monitoring the test and stopping it when a failure was suspected. A newly developed technique along with variations of published methods were also applied to the experimental data. The published methods experienced some success in detecting initial pitting before it progressed to affect the overall root-mean-square (RMS) vibration level. The new technique robustly detected the damage on all of the tests and, in most cases, continued to react to the damage as it spread and increased in severity. Since no single method was able to consistently predict the damage first on all the runs, it was concluded that the best approach to reliably detect pitting damage is to use a combination of detection methods. Author (revised)

N93-27112*# Moog, Inc., East Aurora, NY. Missile Systems Div.
STUDY OF HYDRAULIC ACTUATION SYSTEM FOR SPACE SHUTTLE MAIN ENGINE PROPELLANT VALVES Final Report, Dec. 1992 - 31 May 1993
Bob Ewel, ed. 1 Jun. 1993 71 p
(Contract NAS8-39711)
(NASA-CR-193136; NAS 1.26:193136) Avail: CASI HC A04/MF A01

Recent performance concerns involving the Space Shuttle Main Engine Propellant Valve Actuator assemblies prompted the NASA Marshall Space Flight Center to request an independent design assessment. Moog Inc. responded to this request and received a study contract with objectives of increasing valve reliability, decreasing maintenance costs while preserving the existing design interfaces. The results of the Propellant Valve Actuation System review focus on contamination control and the bypass valve design. Three proof of concept bypass valves employing design changes were built and successfully tested. Test results are presented. Author (revised)

N93-27133*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
FACE-GEAR DRIVES: DESIGN, ANALYSIS, AND TESTING FOR HELICOPTER TRANSMISSION APPLICATIONS
F. L. Litvin (Illinois Univ., Chicago.), J.-C. Wang (Illinois Univ., Chicago.), R. B. Bossler, Jr. (Lucas Western, Inc., City of Industry, CA.), Y.-J. D. Chen (McDonnell-Douglas Helicopter Co., Mesa, AZ.), G. Heath (McDonnell-Douglas Helicopter Co., Mesa, AZ.), and D. G. Lewicki Oct. 1992 16 p Presented at the AGMA 1992 Fall Technical Meeting, Baltimore, MD, 26-28 Oct. 1992; sponsored by American Gear Manufacturers Association
(DA Proj. 1L1-62211-A-47-A; RTOP 505-63-36)
(NASA-TM-106101; E-7743; NAS 1.15:106101; AVSCOM-TR-92-C-009)
Avail: CASI HC A03/MF A01

The use of face-gears in helicopter transmissions was explored. A light-weight, split-torque transmission design utilizing face-gears is described. Face-gear design and geometry were investigated. Topics included tooth generation, limiting inner and outer radii, tooth contact analysis, contact ratio, gear eccentricity, grinding, and structural stiffness. Design charts were developed to determine minimum and maximum face-gear inner and outer radii. An analytical study showed that the face-gear drive is relatively insensitive to gear misalignment with respect to transmission errors, but the tooth contact is affected by misalignment. A method of localizing the bearing contact to permit operation with misalignment was explored. Two new methods for grinding of the face-gear tooth surfaces were also investigated. The proper choice of shaft stiffness enabled good load sharing in the split-torque transmission design. Face-gear experimental studies were also conducted. These tests demonstrated the feasibility of face-gears in high-speed, high-load applications such as helicopter transmissions.
Author

N93-27145*# Cincinnati Univ., OH. Dept. of Aerospace Engineering and Engineering Mechanics.
ANALYSIS OF VIRTUAL PASSIVE CONTROLLERS FOR FLEXIBLE SPACE STRUCTURES Final Report, Jun. 1991 - Dec. 1992
Trevor W. Williams Dec. 1992 52 p
(Grant NAG1-1284)
(NASA-CR-193084; NAS 1.26:193084) Avail: CASI HC A04/MF A01

The dynamics of flexible spacecraft are not usually well known before launch. This makes it important to develop controllers for such systems that can never be destabilized by perturbations in the structural model. Virtual passive controllers, or active vibration absorbers, possess this guaranteed stability property; they mimic a fictitious flexible structure attached to the true physical one. This report analyzes the properties of such controllers, and shows that disturbance absorption behavior can be naturally described in terms of a set of virtual zeros that they introduce into the closed-loop dynamics of the system. Based on this analysis, techniques are then derived for selecting the active vibration absorber internal parameters, i.e., the gain matrices of such controllers, so as to achieve specified control objectives. Finally, the effects on closed-loop stability of small delays in the feedback loop are investigated. Such delays would typically be introduced by a digital implementation of an active vibration absorber. It is shown that these delays only affect the real parts of the eigenvalues of a lightly-damped structure. Furthermore, it is only the high-frequency modes that are destabilized by delays; low-frequency modes are actually made more heavily damped. Eigenvalue perturbation methods are used to obtain accurate predictions of the critical delay at which a given system will become unstable; these methods also determine which mode is critical. Author

N93-27159*# Colorado Univ., Boulder.
ADAPTIVE CONTROL STRATEGIES FOR FLEXIBLE ROBOTIC ARM Current Status Report, 15 Jul. 1992 - 14 May 1993
Jan T. Bialasiewicz 1993 37 p
(Grant NAG1-1444)
(NASA-CR-193111; NAS 1.26:193111) Avail: CASI HC A03/MF A01

The motivation of this research came about when a neural network direct adaptive control scheme was applied to control the tip position of a flexible robotic arm. Satisfactory control performance was not attainable due to the inherent non-minimum phase characteristics of the flexible robotic arm tip. Most of the existing neural network control algorithms are based on the direct method and exhibit very high sensitivity if not unstable closed-loop behavior. Therefore a neural self-tuning control (NSTC) algorithm is developed and applied to this problem and showed promising results. Simulation results of the NSTC scheme and the conventional self-tuning (STR) control scheme are used to examine performance factors such as control tracking mean square error, estimation mean square error, transient response, and steady state response. Author (revised)

N93-27268*# United Technologies Corp., Stratford, CT. Aircraft Div.
SIKORSKY AIRCRAFT ADVANCED ROTORCRAFT TRANSMISSION (ART) PROGRAM Final Report
Jules G. Kish Mar. 1993 209 p
(Contract NAS3-25423; DA Proj. 1L1-62211-A-47-A; RTOP 505-62-10)
(NASA-CR-191079; NAS 1.26:191079; ARL-CR-49) Avail: CASI HC A10/MF A03

The objectives of the Advanced Rotorcraft Transmission program were to achieve a 25 percent weight reduction, a 10 dB noise reduction, and a 5,000 hour mean time between removals (MTBR). A three engine Army Cargo Aircraft (ACA) of 85,000 pounds gross weight was used as the baseline. Preliminary designs were conducted of split path and split torque transmissions to evaluate weight, reliability, and noise. A split path gearbox was determined to be 23 percent lighter, greater than 10 dB quieter, and almost four times more reliable than the baseline two stage planetary design. Detail design studies were conducted of the chosen split path configuration, and drawings were produced of a 1/2 size gearbox consisting of a single engine path of the split path section. Fabrication and testing was then conducted on the 1/2 size gearbox. The 1/2 size gearbox testing proved that the concept of the split path gearbox with high reduction ratio double helical output gear was sound. The improvements were attributed to extensive use of composites, spring clutches, advanced high hot hardness gear steels, the split path configuration itself, high reduction ratio, double helical gearing on the output stage, elastomeric load sharing devices, and elimination of accessory drives. Author (revised)

N93-27380# Technische Univ., Eindhoven (Netherlands).
A SYSTEM FOR MEASUREMENT AND CONTROL OF WELD POOL GEOMETRY IN AUTOMATIC ARC WELDING Ph.D. Thesis
Henricus C. F. M. Wezenbeek 1992 134 p
(ETN-93-93154) Avail: CASI HC A07/MF A02

A system developed for measurement of the weld pool geometry during

gas metal arc welding process is described. It differs from most existing sensor systems in that the state of the welding process is determined rather than the variation in welding circumstances. This makes it possible to react to process disturbances other than the geometric variations as well. Ways in which this type of measurement can contribute to controlling the quality of the weld are indicated. The system developed comprises a video camera, pointing at the welding spot. A dedicated computer is used to analyze the images captured with the camera and determines whether and how the process could be adjusted to achieve the process state that can lead to an acceptable weld quality. ESA

N93-27412# Draper (Charles Stark) Lab., Inc., Cambridge, MA.
COMPARISON OF MAJOR PARAMETERS IN ELECTRODYNAMIC AND ELECTROMAGNETIC LEVITATION TRANSPORT SYSTEMS Final Report, Jul. 1991 - Sep. 1992
W. S. Brown, C. R. Dauwalter, F. Heger, and M. S. Weinberg Sep. 1992 223 p
(Contract DTFR53-91-C-00055)
(PB93-154755; CSDL-R-2420; DOT/FRA/NMI-92/15) Avail: CASI HC A10/MF A03

The study compiles quantitative design information that can be used in selecting a high-speed magnetic levitation system. Analytic models were developed for three configurations of electromagnetic (EMS) and three electrodynamic (EDS) systems, and for linear induction and synchronous motors. The models permit comparisons based on consistent assumptions. The following results indicate that the hoped-for advantages of EDS are difficult to realize: (1) all of the systems studied require smooth guideways to achieve acceptable ride quality unless active control techniques are developed; (2) the estimated weight of the superconducting magnets for the EDS systems is surprisingly large and comparable to the weight of the EMS onboard electromagnets; and (3) real power consumption in sheet guideway null flux EDS is similar to EMS when practical configurations and end effects are considered. NTIS

N93-27593*# Alabama Univ., Huntsville. Dept. of Electrical and Computer Engineering.
WELDING PROCESS MODELLING AND CONTROL Final Technical Report, 26 Feb. 1992 - 25 Feb. 1993
Peter L. Romine and Jinen A. Adenwala 16 Apr. 1993 44 p
(Contract NAS8-38609)
(NASA-CR-192549; NAS 1.26:192549) Avail: CASI HC A03/MF A01

The research and analysis performed, and software developed, and hardware/software recommendations made during 1992 in development of the PC-based data acquisition system for support of Welding Process Modeling and Control is reported. A need was identified by the Metals Processing Branch of NASA Marshall Space Flight Center, for a mobile data aquisition and analysis system, customized for welding measurement and calibration. Several hardware configurations were evaluated and a PC-based system was chosen. The Welding Measurement System (WMS) is a dedicated instrument, strictly for the use of data aquisition and analysis. Although the WMS supports many of the functions associated with the process control, it is not the intention for this system to be used for welding process control. Author (revised)

N93-27641*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
VIBRATION AND NOISE ANALYSIS OF A GEAR TRANSMISSION SYSTEM
F. K. Choy (Akron Univ., OH.), W. Qian (Akron Univ., OH.), J. J. Zakrajsek, and F. B. Oswald Jun. 1993 17 p Presented at the 28th Joint Propulsion Conference and Exhibit, Monterey, CA, 28-30 Jun. 1993; sponsored by AIAA, SAE, ASME, and ASEE
(RTOP 505-62-10)
(NASA-TM-106162; E-7859; NAS 1.15:106162; AIAA Paper 93-2150; ARL-MR-77) Avail: CASI HC A03/MF A01

This paper presents a comprehensive procedure to predict both the vibration and noise generated by a gear transmission system under normal operating conditions. The gearbox vibrations were obtained from both numerical simulation and experimental studies using a gear noise test rig. In addition, the noise generated by the gearbox vibrations was recorded during the experimental testing. A numerical method was used to develop linear relationships between the gearbox vibration and the generated noise. The hypercoherence function is introduced to correlate the nonlinear relationship between the fundamental noise frequency and its harmonics. A numerical procedure was developed using both the linear and nonlinear relationships generated from the experimental data to predict noise resulting from the gearbox vibrations. The application of this methodology is demonstrated by comparing the numerical and experimental results from the gear noise test rig. Author (revised)

N93-27687*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
GENERATION OF HELICAL GEARS WITH NEW SURFACES, TOPOLOGY BY APPLICATION OF CNC MACHINES
F. L. Litvin (Illinois Univ., Chicago.), N. X. Chen (Illinois Univ., Chicago.), C. L. Hsiao (Illinois Univ., Chicago.), and R. F. Handschuh (Army Research Lab., Cleveland, OH.) May 1993 6 p Presented at the 29th Joint Propulsion Conference and Exhibit, Monterey, CA, 28-30 Jun. 1993; cosponsored by AIAA, SAE, ASME, ASEE Prepared in cooperation with Army Research Lab., Adelphi, MD
(RTOP 505-62-10; DA Proj. 1L1-62211-A-47-A)
(NASA-TM-106175; E-7875; NAS 1.15:106175; ARL-TR-9; AIAA Paper 93-2297) Avail: CASI HC A02/MF A01

Analysis of helical involute gears by tooth contact analysis shows that such gears are very sensitive to angular misalignment that leads to edge contact and the potential for high vibration. A new topology of tooth surfaces of helical gears that enables a favorable bearing contact and a reduced level of vibration is described. Methods for grinding of the helical gears with the new topology are proposed. A TCA (tooth contact analysis) program for simulation of meshing and contact of helical gears with the new topology has been developed. Numerical examples that illustrate the proposed ideas are discussed. Author

N93-27832# Technical Research Centre of Finland, Espoo. Ship Lab.
INTERACTION BETWEEN ICE AND PROPELLER
Matti Jussila and Harri Soininen Sep. 1991 84 p
(VTT-TIED-1281; ISBN-951-38-4014-X; ETN-93-93776) Copyright Avail: CASI HC A05/MF A01

A state of art review of work aiming to achieve a practical dimensioning tool for ice operating ship machineries is presented. The main emphasis is on various models of propeller-ice interaction. This was chosen as the starting point since the loads impacted to the shaft system originate from the propeller. Further work is needed to cover the requirements of the shaft modeling. The most important existing models of propeller-ice interaction are presented. The equations are worked out and the theoretical idea of each method is discussed. A few published field measurements are outlined. The areas of lack of knowledge are discussed. The basics of the present ice regulations for machineries are presented, without details of the equations. The physical background for the ice load is revealed to be vague. ESA

N93-27928# Argonne National Lab., IL.
DYNAMICS AND CONTROLS IN MAGLEV SYSTEMS
Y. Cai, S. S. Chen, and D. M. Rote Sep. 1992 75 p
(Contract W-31-109-eng-38)
(AD-A263087; ANL-92/43) Avail: CASI HC A04/MF A01

The dynamic response of magnetically levitated (maglev) ground transportation systems has important consequences for safety and ride quality, guideway design, and system costs. Ride quality is determined by vehicle response and by environmental factors such as humidity and noise. The dynamic response of the vehicles is the key element in determining ride quality, and vehicle stability is an important safety-related element. To design a proper guideway that provides acceptable ride quality in the stable region, vehicle dynamics must be understood. Furthermore, the trade-off between guideway smoothness and the levitation and control systems must be considered if maglev systems are to be economically feasible. The link between the guideway and the other maglev components is vehicle dynamics. For a commercial maglev system, vehicle dynamics must be analyzed and tested in detail. In this study, the role of dynamics and controls in maglev vehicle/guideway interactions is discussed, and the literature on modeling the dynamic interactions of vehicle/guideway and suspension controls for ground vehicles is reviewed. DTIC

N93-28050*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

DYNAMIC ANALYSIS OF SPUR GEARS USING COMPUTER PROGRAM DANST

Fred B. Oswald, Hsiang Hsi Lin (Memphis State Univ., TN.), Chuen-Huei Liou (Memphis State Univ., TN.), and Mark J. Valco Jun. 1993 14 p Proposed for presentation at the 29th Joint Propulsion Conference and Exhibit, Monterey, CA, 28-30 Jun. 1993; sponsored by AIAA, SAE, ASME, and ASEE

(DA Proj. 1L1-62211-A-47-A; RTOP 505-62-10)

(NASA-TM-106211; E-7921; NAS 1.15:106211; ARL-TR-171; AIAA Paper 93-2295) Avail: CASI HC A03/MF A01

DANST is a computer program for static and dynamic analysis of spur gear systems. The program can be used for parametric studies to predict the effect on dynamic load and tooth bending stress of spur gears due to operating speed, torque, stiffness, damping, inertia, and tooth profile. DANST performs geometric modeling and dynamic analysis for low- or high-contact-ratio spur gears. DANST can simulate gear systems with contact ratio ranging from one to three. It was designed to be easy to use, and it is extensively documented by comments in the source code. This report describes the installation and use of DANST. It covers input data requirements and presents examples. The report also compares DANST predictions for gear tooth loads and bending stress to experimental and finite element results. Author (revised)

N93-28127*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

AN APPARATUS FOR GRIPPING TEST SPECIMENS Patent Application

Rebecca MacKay, inventor (to NASA) and Michael V. Nathal, inventor (to NASA) 2 Apr. 1993 14 p

(NASA-Case-LEW-15345-2; NAS 1.71:LEW-15345-2;

US-Patent-Appl-SN-039735) Avail: CASI HC A03/MF A01

A pair of solid-teeth wedges are employed in an improved gripping system. These wedges fit inside a pair of plates having an angled cavity to accommodate them. As stress is applied to the specimen, the wedges are urged toward the specimen by the angled cavity to increase the gripping force. NASA

N93-28129*# National Aeronautics and Space Administration. Pasadena Office, CA.

EXTENDED TASK SPACE CONTROL FOR ROBOTIC MANIPULATORS Patent Application

Paul G. Backes, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) and Mark K. Long, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) 24 Mar. 1993 46 p

(Contract NAS7-918)

(NASA-Case-NPO-18902-1-CU; NAS 1.71:NPO-18902-1-CU;

US-Patent-Appl-SN-034607) Avail: CASI HC A03/MF A01

The invention is a method of operating a robot in successive sampling intervals to perform a task. The robot is comprised of joints and joint actuators, which make use of actuator control loops. The actuators decompose the task into behavior forces that are comprised of accelerations, velocities, and positions of robotic behaviors. The actuator accelerations, velocities, and positions of the current sampling interval are stored for use during the next sampling interval. NASA

N93-28131*# National Aeronautics and Space Administration. Pasadena Office, CA.

SEPARATION TOOL FOR MULTIPIN ELECTRICAL CONNECTORS Patent Application

Larry D. Smith, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) 30 Mar. 1993 16 p

(Contract NAS7-918)

(NASA-Case-NPO-18786-1-CU; NAS 1.71:NPO-18786-1-CU;

US-Patent-Appl-SN-048871) Avail: CASI HC A03/MF A01

A hydraulic tool for safely separating one multipin electrical connector from another is presented. The separation tool consists of a master cylinder which operates a pair of slave cylinders. Each slave cylinder has a corresponding operative shaft and an extraction tab. The slave cylinders are spaced apart from one another so that they may be positioned on either side of mated connector pairs of different sizes and so that their extraction tabs may be slid between the connectors. When the master cylinder's plunger is operated, its operation is hydraulically transmitted to the operative shafts of the slave cylinders which extend outward and, once pressed against a substrate, causes the slave cylinders and corresponding extractor tabs to move away and separate one connector from the other. A second preferred separation tool includes an additional pair of extractor tabs, one at the end of each operative shaft, so that the tool can be used to separate a mated connector pair hanging in free space. NASA

N93-28152# Sandia National Labs., Albuquerque, NM.

OPTIMAL CONFIGURATION ANALYSIS FOR THE ROBOTIC ALL-TERRAIN LUNAR EXPLORATION ROVER

P. R. Klarer and J. W. Purvis 1993 6 p Presented at the 5th Topical Meeting on Robotics and Remote Systems, Knoxville, TN, 26-29 Apr. 1993 (Contract DE-AC04-76DP-00789)

(DE93-008340; SAND-93-0076C; CONF-930403-24) Avail: CASI HC A02/MF A01

A robotic rover vehicle designed for use in the exploration of the Lunar surface is described. The Robotic All-Terrain Lunar Exploration Rover (RATLER) is a four wheeled all-wheel-drive dual-body vehicle. A uniquely simple method of chassis articulation is employed which allows all four wheels to remain in contact with the ground, even while climbing over step-like obstacles as large as approximately 1.3 wheel diameters. Skid steering and modular construction are used to produce a simple, rugged, highly agile mobility chassis with fewer parts required compared to other designs being considered for planetary exploration missions. The design configuration, mobility parameters, and performance of several existing RATLER prototypes are discussed, with emphasis on an analysis of the configuration parameters which directly affect the design's mobility performance. DOE

N93-28326*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

HYBRID BEARINGS FOR TURBOPUMPS AND THE LIKE Patent Application

John F. Justak, inventor (to NASA) (Pratt and Whitney Aircraft, West Palm Beach, FL.) and Gregg R. Owens, inventor (to NASA) (Pratt and Whitney Aircraft, West Palm Beach, FL.) 27 Jan. 1993 15 p

(NASA-Case-MFS-28491-1; NAS 1.71:MFS-28491-1;

US-Patent-Appl-SN-010030) Avail: CASI HC A03/MF A01

In rocket engines power is usually obtained by burning fuel and oxidizer which are mixed, pressurized, and directed to a combustion chamber by means of turbopumps. Roller bearings are generally used in these turbopumps, but because of bearing demands hydrostatic bearings were proposed. The use of such bearings is quite feasible because during flight hydrostatic lubrication can reduce roller bearing wear. A disadvantage of such proposals is that during startup, acceleration, and shutdown high pressure fluids are not available for hydrostatic bearings. The fluid lubrication film is not always present in bearings of turbopumps. During these periods a second bearing is required to carry the load. This requirement suggests the use of hybrid bearings in rocket engine turbopumps. Such duplex bearings were provided, but when their inner races are keyed to the shaft or journal two of them are required. And such duplex bearings do not wear evenly. A hybrid hydrostatic-rolling element bearing was provided wherein the rolling element bearing is locked on the stationary housing rather than on the rotating journal. Author (revised)

N93-28411*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

EFFECT OF EXTENDED TOOTH CONTACT ON THE MODELING OF SPUR GEAR TRANSMISSIONS

Fred B. Oswald, John J. Coy, Hsiang Hsi Lin (Memphis State Univ., TN.), and Jifeng Wang (Memphis State Univ., TN.) May 1993 12 p Presented at the 29th Joint Propulsion Conference and Exhibit, Monterey, CA, 28-30 Jun. 1993; sponsored by AIAA, SAE, ASME, and ASEE Prepared in cooperation with Army Research Lab., Cleveland, OH

(DA Proj. 1L1-62211-A-47-A; RTOP 505-62-10)

(NASA-TM-106174; E-7874; NAS 1.15:106174; ARL-TR-159; AIAA Paper 93-2148) Avail: CASI HC A03/MF A01

In some gear dynamic models, the effect of tooth flexibility is ignored when the model determines which pairs of teeth are in contact. Deflection of loaded teeth is not introduced until the equations of motion are solved.

This means the zone of tooth contact and average tooth meshing stiffness are underestimated and the individual tooth load is overstated, especially for heavily-loaded gears. The static transmission error and dynamic load of heavily-loaded, low-contact-ratio spur gears is compared with this effect both neglected and included. Neglecting the effect yields an underestimate of resonance speeds and an overestimate of the dynamic load.
Author (revised)

N93-28413 Ohio State Univ., Columbus.
ELASTOHYDRODYNAMIC LUBRICATION OF MULTILAYERED ELASTIC SOLIDS Ph.D. Thesis
Abdallah Abdelfattah Elsharkawy 1992 239 p
Avail: Univ. Microfilms Order No. DA9307747

A general mathematical formulation and an efficient numerical model are developed for the isothermal elastohydrodynamic lubrication of multilayered elastic solids. The analysis is limited to line contacts. A dry-contact solution for multilayered elastic solids is developed first in order to obtain the actual contact pressure and the contact area. The elastohydrodynamic lubrication formulation is based on solving the Reynolds equation coupled with the elasticity equations of multilayered elastic half-space. The effects of pressure inside the conjunction on the lubricant viscosity and density are considered in the mathematical formulation. The non-Newtonian behavior of the lubricant associated with a limiting shear strength is incorporated into the analysis. This mathematical model is nonlinear and the system approach is used for numerical solutions. Results, such as pressure and shear stress profiles, film shapes, and subsurface stress patterns to illustrate the effects of surface coating in elastohydrodynamically lubricated line contacts, are presented and discussed. Dissert. Abstr.

N93-28433# Pacific Northwest Lab., Richland, WA.
EXTREMELY HIGH RATE DEPOSITION OF POLYMER MULTILAYER OPTICAL THIN FILM MATERIALS
J. D. Affinito 1993 40 p
(Contract DE-AC06-76RL-01830)
(DE93-009127; PNL-SA-19533) Avail: CASI HC A03/MF A01

A new technique for extremely high rate deposition of optical dielectric films (vacuum deposition of polymer multilayer thin films) is highlighted. This is a way to produce multilayer optical filters comprised of thousands of layers of either linear or nonlinear optical materials. The technique involves the flash evaporation of an acrylic monomer onto a moving substrate; the monomer is then cured. Acrylic polymers deposited to date are very clear for wavelengths between 0.35 and 2.5 microns; they have extinction coefficients of k is approximately 10(exp -7). Application of electric field during crosslinking can polarize ('pole') the film to greatly enhance the nonlinear optical properties. 'Poling' films with the polymer multilayer technique offers advantages over conventional approaches, in that the polarization should not decay over time. Battelle's Pacific Northwest Laboratory is well suited for bringing linear and nonlinear polymer multilayer optical filter technology to manufacturing production status for batch and wide area web applications. DOE

N93-28439# Institut National de Recherche d'Informatique et d'Automatique, Valbonne (France). Programme 4: Robotique, Image et Vision.
PARALLEL MANIPULATORS. PART 5: DETERMINATION OF THE WORKSPACE FOR A CONSTANT ORIENTATION [MANIPULATEURS PARALLELES, 5EME PARTIE: DETERMINATION DE L'ESPACE DE TRAVAIL A ORIENTATION CONSTANTE]
Jean-Pierre Merlet Mar. 1992 80 p In FRENCH
(INRIA-RR-1645; ETN-93-93898) Avail: CASI HC A05/MF A01

The workspace of a six degrees of freedom parallel manipulator is bounded because of the limitations on the articular coordinates (links lengths), but also because of the mechanical limits on the joints and links inteference. Usually the boundary of the workspace is determined by fixing four of the six degrees of freedom to get planar cross sections. A discretization method is then used which yields to high computation time, and, sometimes, to errors as the workspace may be complex. A geometrical method to determine exactly the boundary of the workspace due to the limitations on the articular coordinates and mechanical limits on the articulation is proposed. This method enables the subzones in the resulting zone for which the distance between the links is always greater than a fixed limit to be determined. This method is illustrated on various examples. ESA

N93-27556*# Proto-Technology Corp., Groton, CT.
MAGNETIC BEARINGS: FIFTY YEARS OF PROGRESS
Michael K. Swann *In* NASA. Langley Research Center, Magnetic Suspension Technology Workshop 1993 p 19-38 (For primary document see N93-27554 10-18)
Avail: CASI HC A03/MF A03

N93-27557*# Magnetic Bearings, Inc., Radford, VA.
MAGNETIC BEARING TURBOMACHINERY CASE HISTORIES AND APPLICATIONS FOR SPACE RELATED EQUIPMENT
David A. Weise *In* NASA. Langley Research Center, Magnetic Suspension Technology Workshop 1993 p 41-48 (For primary document see N93-27554 10-18)
Avail: CASI HC A02/MF A03

N93-27558*# Virginia Univ., Charlottesville. Dept. of Electrical Engineering.
DIGITAL CONTROL OF MAGNETIC BEARINGS SUPPORTING A MULTIMASS FLEXIBLE ROTOR
F. J. Keith, R. D. Williams, P. E. Allaire, and R. M. Schafer (Tellabs Research Lab., Mishawaka, IN.) *In* NASA. Langley Research Center, Magnetic Suspension Technology Workshop 1993 p 53-71 (For primary document see N93-27554 10-18)
Avail: CASI HC A03/MF A03

N93-27560*# Cornell Univ., Ithaca, NY. Sibley School of Mechanical and Aerospace Engineering.
A CONSTITUTIVE MODEL FOR THE FORCES OF A MAGNETIC BEARING INCLUDING EDDY CURRENTS
D. L. Taylor and K. V. Hebbale *In* NASA. Langley Research Center, Magnetic Suspension Technology Workshop 1993 p 87-99 Sponsored in part by ONR (For primary document see N93-27554 10-18)
(Contract N00014-80-C-0618)
Avail: CASI HC A03/MF A03

N93-27561*# Mechanical Technology, Inc., Latham, NY. Dept. of Advanced Technology.
MAGNETIC SUSPENSION CHARACTERISTICS OF ELECTROMAGNETIC ACTUATORS
Dantam K. Rao, J. Dill, and E. Zorzi *In* NASA. Langley Research Center, Magnetic Suspension Technology Workshop 1993 p 105-117 (For primary document see N93-27554 10-18)
Avail: CASI HC A03/MF A03

N93-27562*# Massachusetts Inst. of Tech., Cambridge.
DESIGN CONSIDERATIONS FOR ULTRA-PRECISION MAGNETIC BEARING SUPPORTED SLIDES
Alexander H. Slocum and David B. Eisenhaure (SatCon Technology Corp., Cambridge, MA.) *In* NASA. Langley Research Center, Magnetic Suspension Technology Workshop 1993 p 121-138 (For primary document see N93-27554 10-18)
Avail: CASI HC A03/MF A03

N93-27563*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
A MAGNETIC ISOLATION AND POINTING SYSTEM FOR THE ASTROMETRIC TELESCOPE FACILITY
Marcie Smith, William Hibble (Honeywell, Inc., Glendale, AZ.), and Patrick J. Wolke (Honeywell, Inc., Glendale, AZ.) *In* NASA. Langley Research Center, Magnetic Suspension Technology Workshop 1993 p 141-160 (For primary document see N93-27554 10-18)
(Contract NAS2-12525)
Avail: CASI HC A03/MF A03

N93-27565*# Bridgeport Univ., CT.
AN ELECTROMAGNETICALLY LEVITATED TWO-AXIS GIMBALESS POINTING MECHANISM
Gerald T. Volpe *In* NASA. Langley Research Center, Magnetic Suspension

Technology Workshop 1993 p 177-180 (For primary document see N93-27554 10-18)
Avail: CASI HC A01/MF A03

N93-27567*# Virginia Univ., Charlottesville. Dept. of Mechanical and Aerospace Engineering.
DESIGN AND TEST OF A MAGNETIC THRUST BEARING
P. E. Allaire, A. Mikula (Kingsbury, Inc., Philadelphia, PA.), B. Banerjee, D. W. Lewis, and J. Imlach *In* NASA. Langley Research Center, Magnetic Suspension Technology Workshop 1993 p 201-219 (For primary document see N93-27554 10-18)
Avail: CASI HC A03/MF A03

N93-27568*# Mechanical Technology, Inc., Latham, NY.
A CONVENTIONAL POINT OF VIEW ON ACTIVE MAGNETIC BEARINGS
H. Ming Chen and Jim Dill *In* NASA. Langley Research Center, Magnetic Suspension Technology Workshop 1993 p 223-234 (For primary document see N93-27554 10-18)
Avail: CASI HC A03/MF A03

N93-27569*# SatCon Technology Corp., Cambridge, MA.
MAGNETIC BEARINGS FOR A HIGH-PERFORMANCE OPTICAL DISK BUFFER
Richard Hockney and Timothy Hawkey *In* NASA. Langley Research Center, Magnetic Suspension Technology Workshop 1993 p 237-250 (For primary document see N93-27554 10-18)
(Contract NAS5-30058)
Avail: CASI HC A03/MF A03

N93-27570*# Virginia Polytechnic Inst. and State Univ., Blacksburg.
ACTIVE MAGNETIC BEARINGS APPLIED TO INDUSTRIAL COMPRESSORS
R. G. Kirk, J. F. Hustak (Dresser Industries, Inc., Olean, NY.), and K. A. Schoeneck (Dresser Industries, Inc., Olean, NY.) *In* NASA. Langley Research Center, Magnetic Suspension Technology Workshop 1993 p 253-269 (For primary document see N93-27554 10-18)
Avail: CASI HC A03/MF A03

N93-27571*# Virginia Univ., Charlottesville. Dept. of Mechanical and Aerospace Engineering.
PRACTICAL LIMITS TO THE PERFORMANCE OF MAGNETIC BEARINGS: PEAK FORCE, SLEW RATE, AND DISPLACEMENT SENSITIVITY
E. Maslen, P. Hermann (Sundstrand Advanced Technology Group, Rockford, IL.), M. Scott, and R. R. Humphris *In* NASA. Langley Research Center, Magnetic Suspension Technology Workshop 1993 p 273-286 (For primary document see N93-27554 10-18)
Avail: CASI HC A03/MF A03

N93-27573*# Texas A&M Univ., College Station.
AN AC-ELECTROMAGNETIC BEARING FOR FLYWHEEL ENERGY STORAGE IN SPACE
Jorgen L. Nikolajsen *In* NASA. Langley Research Center, Magnetic Suspension Technology Workshop 1993 p 317-323 (For primary document see N93-27554 10-18)
Avail: CASI HC A02/MF A03

N93-27574*# Technical Planning, Inc., Bethesda, MD.
HIGH EFFICIENCY MAGNETIC BEARINGS
Philip A. Studer, Chaitanya P. Jayaraman (Maryland Univ., College Park.), Davinder K. Anand (Maryland Univ., College Park.), and James A. Kirk (Maryland Univ., College Park.) *In* NASA. Langley Research Center, Magnetic Suspension Technology Workshop 1993 p 327-337 (For primary document see N93-27554 10-18)
(Grant NAG5-396)
Avail: CASI HC A03/MF A03

N93-27576*# SatCon Technology Corp., Cambridge, MA.
THE ROLE OF SUPERCONDUCTIVITY IN MAGNETIC BEARINGS FOR HIGH-LOAD APPLICATIONS
James Downer and David Eisenhaure *In* NASA. Langley Research Center, Magnetic Suspension Technology Workshop 1993 p 361-372 (For primary document see N93-27554 10-18)
Avail: CASI HC A03/MF A03

N93-27578*# Massachusetts Inst. of Tech., Cambridge. Electromagnetic and Electronic Systems Lab.
PERFORMANCE OF CERAMIC SUPERCONDUCTORS IN MAGNETIC BEARINGS
James L. Kirtley, Jr. and James R. Downer (SatCon Technology Corp., Cambridge, MA.) *In* NASA. Langley Research Center, Magnetic Suspension Technology Workshop 1993 p 389-404 Sponsored in part by NSF (For primary document see N93-27554 10-18)
Avail: CASI HC A03/MF A03

N93-27820*# Martin Marietta Space Systems, Inc., Denver, CO.
FLIGHT TELEROBOTIC SERVICER
Dennis Haley *In* NASA, Washington, Technology for Space Station Evolution. Volume 4: Power Systems/Propulsion/Robotics 1990 p 401-420 (For primary document see N93-27803 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

N93-27864*# National Aeronautics and Space Administration, Washington, DC.
ROBOTICS TECHNOLOGY DISCIPLINE
Melvin D. Montemerlo *In its* Technology for Space Station Evolution. Executive Summary and Overview 1990 p 197-233 (For primary document see N93-27854 10-18)
Avail: CASI HC A03/MF A03; 1 functional color page

N93-27980*# National Inst. of Standards and Technology, Gaithersburg, MD.
INTELLIGENT ROBOTS FOR PLANETARY EXPLORATION AND CONSTRUCTION
James S. Albus *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 15 p (For primary document see N93-27956 10-91)
Avail: CASI HC A03/MF A03

N93-28040# National Space Development Agency, Tokyo (Japan).
CONCEPTUAL STUDY OF LUNAR ROVING EXPLORER [GETSUMEN IDOU TANSAKI NO GAIKEN KENTOU]
Yutaka Kaneko *In its* Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 19 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

N93-28041# Nissan Motor Co. Ltd., Tokyo (Japan). Aerospace Div.
LUNAR SURFACE ROVING EXPLORER [GETSUMEN IDOU TANSAKI]
Youko Nishio *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 16 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

N93-28042# Fujitsu Ltd., Tokyo (Japan).
LUNAR SURFACE ROVING EXPLORER [GETSUMEN IDOU TANSAKI]
Yasushi Inamoto, Satoshi Ishii, and Toshihiko Morita *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 21 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

N93-28048# Toshiba Corp., Tokyo (Japan).
OUTLINE OF MARS EXPLORER SYSTEM [KASEI TANSAKI SISEMEMU NO GAIYOU]
Megumi Suzaki *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 21 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

38 QUALITY ASSURANCE AND RELIABILITY

Includes product sampling procedures and techniques; and quality control.

N93-26668# Ames Lab., IA.
ON THE DIFFERENTIATION OF DIFFUSION BOND STRENGTH USING THE TOTAL ACOUSTIC ENERGY REFLECTED FROM THE BOND
G. C. Ojard (Pratt and Whitney Aircraft, West Palm Beach, FL.), O. Buck, D. K. Rehbein, and M. S. Hughes 1992 10 p Presented at the Review of Progress in Quantitative Non Destructive Evaluation (NDE), La Jolla, CA, 19-24 Jul. 1992
(Contract W-7405-eng-82)
(DE93-008073; IS-M-738; CONF-920799-4) Avail: CASI HC A02/MF A01

Single frequency reflection coefficients and reflected energy over a broad acoustic band (2-15 MHz), and the mechanical bond strength were evaluated on diffusion bonds in Cu/Cu, Cu/Ni, and Ti-6Al-4V/self. Results indicate that energy data are more sensitive to small bond strength changes as predicted by Parseval's theorem. In all cases, the energy reflected mainly originates at voids still present at the original interface location. Other microstructural features caused by the interdiffusion appear to diminish the reflected energy. DOE

N93-27025*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
RENEW V3.2 USER'S MANUAL, MAINTENANCE ESTIMATION SIMULATION FOR SPACE STATION FREEDOM PROGRAM
Bruce L. Bream Apr. 1993 47 p
(NASA-TM-106006; E-7763; NAS 1.15:106006) Avail: CASI HC A03/MF A01

RENEW is a maintenance event estimation simulation program developed in support of the Space Station Freedom Program (SSFP). This simulation uses reliability and maintainability (R&M) and logistics data to estimate both average and time dependent maintenance demands. The simulation uses Monte Carlo techniques to generate failure and repair times as a function of the R&M and logistics parameters. The estimates are generated for a single type of orbital replacement unit (ORU). The simulation has been in use by the SSFP Work Package 4 prime contractor, Rocketdyne, since January 1991. The RENEW simulation gives closer estimates of performance since it uses a time dependent approach and depicts more factors affecting ORU failure and repair than steady state average calculations. RENEW gives both average and time dependent demand values. Graphs of failures over the mission period and yearly failure occurrences are generated. The averages demand rate for the ORU over the mission period is also calculated. While RENEW displays the results in graphs, the results are also available in a data file for further use by spreadsheets or other programs. The process of using RENEW starts with keyboard entry of the R&M and operational data. Once entered, the data may be saved in a data file for later retrieval. The parameters may be viewed and changed after entry using RENEW. The simulation program runs the number of Monte Carlo simulations requested by the operator. Plots and tables of the results can be viewed on the screen or sent to a printer. The results of the simulation are saved along with the input data. Help screens are provided with each menu and data entry screen. Author

N93-27080*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
DETERMINATION OF PLATE WAVE VELOCITIES AND DIFFUSE FIELD DECAY RATES WITH BRAOD-BAND ACOUSTO-ULTRASONIC SIGNALS
Harold E. Kautz Jun. 1993 11 p Presented at the Second International Conference on Acousto-Ultrasonics, Atlanta, GA, 24-25 Jun. 1993; sponsored by American Society for Nondestructive Testing
(RTOP 510-01-50)
(NASA-TM-106158; E-7844; NAS 1.15:106158) Avail: CASI HC A03/MF A01

Lowest symmetric and lowest antisymmetric plate wave modes were excited and identified in broad-band acousto-ultrasonic (AU) signals collected from various high temperature composite materials. Group velocities have been determined for these nearly nondispersive modes. An algorithm has been developed and applied to determine phase velocities and hence dispersion curves for the frequency ranges of the broad-band pulses. It is demonstrated that these data are sensitive to changes in the various stiffness moduli of the materials, in agreement by analogy, with the theoretical and experimental results of Tang and Henneke on fiber reinforced polymers. Diffuse field decay rates have been determined in the same specimen geometries and AU configuration as for the plate wave measurements. These decay rates are of value in assessing degradation such as matrix cracking in ceramic matrix composites. In addition, we verify that diffuse field decay rates respond to fiber/matrix interfacial shear strength and density in ceramic matrix composites. This work shows that velocity/stiffness and decay rate measurements can be obtained in the same set of AU experiments for characterizing materials and in specimens with geometries useful for mechanical measurements. Author

N93-27398# National Inst. of Standards and Technology, Gaithersburg, MD. Materials Reliability Div.
MATERIALS RELIABILITY. TECHNICAL ACTIVITIES, 1992. (NAS-NRC ASSESSMENT PANEL, 13-14 MAY 1993)
H. I. McHenry and C. M. Fortunko 1993 103 p See also PB92-126424
(PB93-173466; NISTIR-4965) Avail: CASI HC A06/MF A02

The Materials Reliability Division conducts materials research to improve the quality, reliability, and safety of industrial products and the nation's infrastructure. The authors' research fosters the use of advanced materials in commercial products by improving confidence in their service performance. The authors do this by developing measurement technology for: process control which improves the quality, consistency and producibility of materials; nondestructive evaluation (NDE) which assures the quality of finished materials and products; fitness-for-purpose standards which relate material quality to reliability and safety; and materials evaluation for severe applications, particularly for service at cryogenic temperatures. Early in FY92, the authors reorganized the Division to build a stronger group structure. The report summarizes the Division programs, and it is organized according to the three groups: materials characterization; process sensing and modeling; and structural materials. NTIS

N93-27210 Israeli Air Force, Zahal.
DAMAGE TOLERANCE ASSESSMENT AND USAGE VARIATION ANALYSIS FOR C-130 AIRCRAFT IN THE ISRAELI AIR FORCE
D. Schur, E. Makevet, and A. Dumanis *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 368-372 (For primary document see N93-27166 10-01)
Copyright Avail: Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel

39 STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue; and thermal stress.

For applications see *05 Aircraft Design, Testing and Performance* and *18 Spacecraft Design, Testing and Performance.*

N93-26999*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
STRUCTURAL TAILORING OF AIRCRAFT ENGINE BLADE SUBJECT TO ICE IMPACT CONSTRAINTS
E. S. Reddy (Sverdrup Technology, Inc., Brook Park, OH.), G. H. Abumeri (Sverdrup Technology, Inc., Brook Park, OH.), P. L. N. Murthy, and C. C. Chamis Apr. 1993 22 p Presented at the Fourth AIAA/Air Force/OAI Symposium on Multidisciplinary Analysis, Cleveland, OH, 21-23 Sep. 1992; sponsored by AIAA, USAF, and OAI
(RTOP 505-62-OK)
(NASA-TM-106033; E-7599; NAS 1.15:106033) Avail: CASI HC A03/MF A01

Results are presented for the minimum weight design of SR2 unswept blade made of (titanium/graphite-epoxy/titanium) sub s fiber composite. The blade which is rotating at high RPM is subject to ice impact. The root chord length, blade thicknesses at five stations, and graphite-epoxy ply orientation are chosen as design variables. Design constraints are placed on the behavior variables: local leading edge strain and root damage

parameter (combined stress failure criteria) as a function due to ice impact, maximum spanwise centrifugal stress at the root of the deformed blade due to local damage, first three natural frequencies, and resonance margin after impact. The method of feasible directions is employed to solve the inequality constrained minimization problem. The effect of ice speed and the ice impact location on the final design are discussed. Author

N93-27009*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

CONSIDERATIONS CONCERNING FATIGUE LIFE OF METAL MATRIX COMPOSITES

V. M. Radhakrishnan (Indian Inst. of Tech., Madras.) and Paul A. Bartolotta May 1993 11 p Sponsored in part by NAS-NRC

(RTOP 510-01-50)

(NASA-TM-106144; E-7823; NAS 1.15:106144) Avail: CASI HC A03/MF A01

Since metal matrix composites (MMC) are composed from two very distinct materials each having their own physical and mechanical properties, it is feasible that the fatigue resistance depends on the strength of the weaker constituent. Based on this assumption, isothermal fatigue lives of several MMC's were analyzed utilizing a fatigue life diagram approach. For each MMC, the fatigue life diagram was quantified using the mechanical properties of its constituents. The fatigue life regions controlled by fiber fracture and matrix were also quantitatively defined. Author (revised)

N93-27030*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

COMPOSITE MICROMECHANICAL MODELING USING THE BOUNDARY ELEMENT METHOD

Robert K. Goldberg and Dale A. Hopkins Apr. 1993 15 p Presented at the American Society for Composites Seventh Technical Conference on Composite Materials, University Park, PA, 13-15 Oct. 1992; sponsored by the American Society for Composites

(RTOP 510-01-50)

(NASA-TM-106127; E-7796; NAS 1.15:106127) Avail: CASI HC A03/MF A01

The use of the boundary element method for analyzing composite micromechanical behavior is demonstrated. Stress-strain, heat conduction, and thermal expansion analyses are conducted using the boundary element computer code BEST-CMS, and the results obtained are compared to experimental observations, analytical calculations, and finite element analyses. For each of the analysis types, the boundary element results agree reasonably well with the results from the other methodologies, with explainable discrepancies. Overall, the boundary element method shows promise in providing an alternative method to analyze composite micromechanical behavior. Author (revised)

N93-27075*# Old Dominion Univ., Norfolk, VA. Research Foundation.

INCLUSION OF TRANSVERSE SHEAR DEFORMATION IN THE EXACT BUCKLING AND VIBRATION ANALYSIS OF COMPOSITE PLATE ASSEMBLIES

Melvin S. Anderson and David Kennedy Washington May 1993 23 p Previously announced in IAA as A92-34305 Prepared in cooperation with Wales Univ. Inst. of Science and Technology, Cardiff

(Contracts NAS1-18584; NCCw-002)

(NASA-CR-4510; NAS 1.26:4510) Avail: CASI HC A03/MF A01

The problem considered is the development of the necessary plate stiffnesses for use in the general purpose program VICONOPT for buckling and vibration of composite plate assemblies. The required stiffnesses include the effects of transverse shear deformation and are for sinusoidal response along the plate length as required in VICONOPT. The method is based on the exact solution of the plate differential equations for a composite laminate having fully populated A, B, and D stiffness matrices which leads to an ordinary differential equation of tenth order. Author

N93-27088*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

A TRANSFER MATRIX APPROACH TO VIBRATION LOCALIZATION IN MISTUNED BLADE ASSEMBLIES

Gisli Ottarson (Michigan Univ., Ann Arbor.) and Chritophe Pierre (Michigan Univ., Ann Arbor.) May 1993 39 p

(Contract NCC3-233; RTOP 505-62-21)

(NASA-TM-106112; E-7764; NAS 1.15:106112; ICOMP-93-10) Avail: CASI HC A03/MF A01

A study of mode localization in mistuned bladed disks is performed using transfer matrices. The transfer matrix approach yields the free response of a general, mono-coupled, perfectly cyclic assembly in closed form. A mistuned structure is represented by random transfer matrices, and the expansion of these matrices in terms of the small mistuning parameter leads to the definition of a measure of sensitivity to mistuning. An approximation of the localization factor, the spatially averaged rate of exponential attenuation per blade-disk sector, is obtained through perturbation techniques in the limits of high and low sensitivity. The methodology is applied to a common model of a bladed disk and the results verified by Monte Carlo simulations. The easily calculated sensitivity measure may prove to be a valuable design tool due to its system-independent quantification of mistuning effects such as mode localization. Author (revised)

N93-27165*# Intelligent Automation Systems, Inc., Rockville, MD.

SIX DEGREE OF FREEDOM ACTIVE VIBRATION DAMPING FOR SPACE APPLICATION Quarterly Progress Report No. 3, 31 Jan. - 30 Apr. 1993

Leonard S. Haynes 2 May 1993 31 p

(Contract NAS7-1198)

(NASA-CR-193028; NAS 1.26:193028) Avail: CASI HC A03/MF A01

Work performed during the period 1 Jan. - 31 Mar. 1993 on six degree of freedom active vibration damping for space application is presented. A performance and cost report is included. Topics covered include: actuator testing; mechanical amplifier design; and neural network control system development and experimental evaluation. CASI

N93-27263*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, CA.

COMPRESSIVE AND SHEAR BUCKLING ANALYSIS OF METAL MATRIX COMPOSITE SANDWICH PANELS UNDER DIFFERENT THERMAL ENVIRONMENTS

William L. Ko and Raymond H. Jackson Washington Jun. 1993 23 p Proposed for presentation at the 7th International Conference on Composite Structures, Paisley, Scotland, Jul. 1993

(RTOP 505-63-40)

(NASA-TM-4492; H-1900; NAS 1.15:4492) Avail: CASI HC A03/MF A01

Combined inplane compressive and shear buckling analysis was conducted on flat rectangular sandwich panels using the Raleigh-Ritz minimum energy method with a consideration of transverse shear effect of the sandwich core. The sandwich panels were fabricated with titanium honeycomb core and laminated metal matrix composite face sheets. The results show that slightly slender (along unidirectional compressive loading axis) rectangular sandwich panels have the most desirable stiffness-to-weight ratios for aerospace structural applications; the degradation of buckling strength of sandwich panels with rising temperature is faster in shear than in compression; and the fiber orientation of the face sheets for optimum combined-load buckling strength of sandwich panels is a strong function of both loading condition and panel aspect ratio. Under the same specific weight and panel aspect ratio, a sandwich panel with metal matrix composite face sheets has much higher buckling strength than one having monolithic face sheets. Author (revised)

N93-27371# Technische Univ., Eindhoven (Netherlands).

SOFTENING OF CONCRETE LOADING IN COMPRESSION Ph.D. Thesis

Rene Alfred Vonk 1992 233 p Sponsored by Netherlands Technology Foundation

(ISBN-9-03-860062-3; ETN-93-93149) Copyright Avail: CASI HC A11/MF A03

Compressive failure of concrete was studied in order to enable reliable modeling of this phenomena. Mechanical analysis and modeling of the structural behavior of softening concrete loaded in compression was concentrated upon. The three dimensional process of crack formation was analyzed as it is governed by the heterogeneity of concrete, the boundary conditions, and dimensions of concrete specimens. A link between fracture mechanics and the modeling of compressive softening of concrete was

made. The behavior of normal strength concrete with relatively stiff and strong aggregates was considered. ESA

N93-27417# Southwest Research Inst., San Antonio, TX. Materials and Mechanics Dept.
FRACTURE MECHANICS ANALYSIS OF NGV FUEL CYLINDERS. PART 1: STEEL CYLINDERS Topical Report, Aug. 1989 - Feb. 1993
M. P. Connolly, S. J. Hudak, and S. Roy Feb. 1993 58 p
(Contract GRI-5086-252-1440)
(PB93-165835; SWRI-06-1566-2-Pt-1; GRI-92/0285-Pt-1) Avail: CASI HC A04/MF A01

Compressed natural gas (CNG) cylinders for natural gas vehicles (NGVs) are subject to a combination of pressure cycles, associated with periodic refueling, and a potentially corrosive CNG environment. Under these conditions it has been shown that the life of the cylinder is governed by the corrosion-fatigue crack growth of internal flaws such as voids, pits or folds that may be present after manufacture. For NGV applications, these cylinders are required to operate for at least 15 years and the report, through a detailed fracture mechanics analysis, describes approaches to achieving the desired life. The analysis shows that a 15 year cylinder life can be obtained by using quality control to ensure that no initial defects greater than 0.045 in. X 0.090 in. exist after manufacture. Alternatively, gas drying can be used at the distribution stations to reduce the detrimental effects of the remaining CNG impurities, and thereby, produce long cylinder lives. The analysis also considers the role of in-service inspection/retest and shows that in-service NDE has little advantage, either technically or economically, for ensuring the fitness-for-service of steel NGV cylinders. The analysis also shows that hydrostatic testing of cylinders, either at manufacture or in service, is ineffective for detecting fatigue cracks and therefore should not be implemented as part of a fitness-for-service plan for NGV fuel cylinders. The issue of cylinder geometry was also considered and the analysis shows that improperly designed flat-bottomed CNG cylinders can result in premature fatigue failures originating at the inner wall in the transition region between the cylinder end and sidewall. NTIS

N93-27418# Pennsylvania Univ., Philadelphia. Dept. of Materials Science and Engineering.
KINETICS AND MICROSCOPIC PROCESSES OF LONG TERM FRACTURE IN POLYETHYLENE PIPING MATERIALS Final Report, 1 Feb. 1991 - 1 Feb. 1992
N. Brown and X. Lu 21 Jul. 1992 157 p See also PB92-108844
(Contract GRI-5087-260-1468)
(PB93-167146; GRI-92/0286) Avail: CASI HC A08/MF A02

The report contains 9 completed works as follows: The Dependence of Slow Crack Growth in a Polyethylene Copolymer on Testing Temperature and Morphology; A Test of Slow Crack Growth Failure of PE Under Constant Load; Effect of Annealing on Slow Crack Growth in an Ethylene-Hexene Copolymer; The Fundamental Material Parameters that Govern Slow Crack Growth in Linear Polyethylene; Slow Crack Growth in Blends of HDPE and UHMWPE; The Mechanism of Fatigue Failure in a Polyethylene Copolymer; PENT Quality Control Test for PE Gas Pipes and Resins; International Round Robin Study of a Fatigue Test Approach to the Ranking of Polyethylene Pipe Material; and Proposed ASTM Specification for ASTM F17.40 Test Methods Committee. NTIS

N93-27585*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EXACT METHODS FOR MODAL TRANSIENT RESPONSE ANALYSIS INCLUDING FEEDBACK CONTROL
Melvin S. Anderson (Old Dominion Univ., Norfolk, VA.) and W. Keith Belvin Washington May 1993 16 p
(RTOP 590-14-61-01)
(NASA-TP-3317; L-17155; NAS 1.60:3317) Avail: CASI HC A03/MF A01

This paper presents a modal method for the analysis of controlled structural systems that retains the uncoupled nature of the classical transient response analysis of a structure subjected to a prescribed time-varying load. The control force is expanded as a Taylor series that remains on the right side of the equations, and it does not lead to a computational approach that requires coupling between modes on the left side. Retaining a sufficient number of terms in the series produces a solution to the modal equations that is accurate to machine precision. The approach is particularly attractive for large problems in which standard matrix exponential methods become computationally prohibitive. Numerical results are presented to show the accuracy and efficiency of the proposed approach for dynamic feedback compensation of a truss structure with local member modes in the controller bandwidth. Author

N93-27594*# Virginia Univ., Charlottesville. Dept. of Mechanical, Aerospace and Nuclear Engineering.
MAGNETIC ACTUATORS AND SUSPENSION FOR SPACE VIBRATION CONTROL Final Report, 1 Jun. 1988 - 17 Apr. 1992
Carl R. Knospe, Paul E. Allaire, and David W. Lewis May 1993 161 p
(Grant NAG3-909)
(NASA-CR-193038; NAS 1.26:193038; UVA/528292/MANE93/101) Avail: CASI HC A08/MF A02

The research on microgravity vibration isolation performed at the University of Virginia is summarized. This research on microgravity vibration isolation was focused in three areas: (1) the development of new actuators for use in microgravity isolation; (2) the design of controllers for multiple-degree-of-freedom active isolation; and (3) the construction of a single-degree-of-freedom test rig with umbilicals. Described are the design and testing of a large stroke linear actuator; the conceptual design and analysis of a redundant coarse-fine six-degree-of-freedom actuator; an investigation of the control issues of active microgravity isolation; a methodology for the design of multiple-degree-of-freedom isolation control systems using modern control theory; and the design and testing of a single-degree-of-freedom test rig with umbilicals. For individual title, see N93-27595.

N93-27595*# Virginia Univ., Charlottesville. Dept. of Mechanical, Aerospace and Nuclear Engineering.
[EVALUATION OF ACTUATORS FOR THE SDOF AND MDOF ACTIVE MICROGRAVITY ISOLATION SYSTEMS]
In its Magnetic Actuators and Suspension for Space Vibration Control May 1993 45 p (For primary document see N93-27594 10-39)
Avail: CASI HC A03/MF A02

The University of Virginia examined the design of actuators for both single-degree-of-freedom (SDOF) and multiple-degree-of-freedom (MDOF) active microgravity isolation systems. For SDOF systems, two actuators were considered: a special large gap magnetic actuator and a large stroke Lorentz actuator. The magnetic actuator was viewed to be of greater difficulty than the Lorentz actuator with little compelling technical advantage and was dropped from consideration. A Lorentz actuator was designed and built for the SDOF test rig using magnetic circuit and finite element analysis. The design and some experimental results are discussed. The University also examined the design of actuators for MDOF isolation systems. This includes design of an integrated 1 cm gap 6-DOF noncontacting magnetic suspension system and of a 'coarse' follower which permits the practical extension of magnetic suspension to large strokes. The proposed 'coarse' actuator was a closed kinematic chain manipulator known as a Stewart Platform. The integration of the two isolation systems together, the isolation tasks assigned to each, and possible control architectures were also explored. The results of this research are examined.
Author (revised)

N93-27698# Stanford Univ., CA. Div. of Applied Mechanics.
MECHANICS IN MATERIAL SPACE Final Report, 1 Apr. 1990 - 31 Jul. 1992
George Herrmann Dec. 1992 27 p
(Grant AF-AFOSR-0195-90)
(AD-A262448; AFOSR-93-0191TR) Avail: CASI HC A03/MF A01

Considerable advances have been achieved during the period reported. Conservation laws and path-independent integrals in non-homogeneous plane elastostatics have been established. Further, conservation laws for non-homogeneous bars and beams of variable cross-section, as well as for non-homogeneous plates have been constructed. These laws should permit a more direct and simple analysis of cracks and other defects in these structural elements. A significant breakthrough came in our success of constructing conservation laws for dissipative systems. Until now, it was possible to construct conservation laws only for systems which had a Lagrangian. We have now succeeded in establishing a general procedure, which we call the Neutral Action method, which allows the construction of conservation laws (and path-independent integrals) for systems with damping,

for which no systematic procedures existed before. Thus we have generalized in an important and practical way the classical, celebrated theorem of Noether to a large class of technically more realistic systems. DTIC

N93-27826# State Univ. of New York, Albany. Research Foundation.
PLASTIC DEFORMATION OF GRANULAR MATERIALS Final Report, 1 Dec. 1989 - 30 Nov. 1992
E. B. Pitman 25 Jan. 1993 12 p
(Grant AF-AFOSR-0076-90)
(AD-A262449; AFOSR-93-0174TR) Avail: CASI HC A03/MF A01

This project combines analytic and computational investigations to understand the dynamics of elastic-plastic deformation of granular materials, particularly issues related to the formation of shearbands. Roughly speaking, shearbands form when the governing equations cease to be wellposed. Our research examines the issue of well-posedness, loss of hyperbolicity, and regularization. This final report summarizes our work on the following: (1) computation of deformation and formation of shear bands in granular material; (2) analysis of a gradient theory of granular plasticity; and (3) related elastic and viscoelastic systems of PDE which may lose hyperbolicity. DTIC

N93-27872# Technische Univ., Delft (Netherlands).
THE FATIGUE BEHAVIOUR OF T- AND X-JOINTS MADE OF SQUARE HOLLOW SECTIONS Ph.D. Thesis
Arnoldus Martinus vanWingerde 1992 183 p
(ETN-93-93598) Avail: CASI HC A09/MF A02

The results of experimental and numerical research in the fatigue behavior of T and X joints between square hollow sections of which the brace is welded to the face of the chord, without any additional stiffeners, are presented. Experimental results of a project in the low cycle fatigue behavior of axially loaded T joints between rectangular hollow sections were used in this work. The aim of the research is to establish a better design method for the fatigue strength of joints in square hollow sections, based on the hot spot stress method. The results are to be proposed for inclusion in Eurocode 3. In the experimental investigation, the Strain Concentration Factors (SCF) are measured at various locations of the joint for comparison with results of the numerical investigations and S-N curves are determined. The numerical work provides SCF values at weld toes for a range of parametric variations in the joint dimensions. These results form the basis for a set of parametric formulae. These formulae allow the determination of the SCF values at the weld toes of the brace and chord, depending on the nondimensional parameters. The results of tests and formulae are used to check the final validity of the formulae in combination with the S-N lines. ESA

N93-27879# Technische Univ., Delft (Netherlands).
MIXED-MODE FRACTURE OF CONCRETE: AN EXPERIMENTAL APPROACH Ph.D. Thesis
Mohamed Buhary Nooru-Mohamed 1992 164 p Sponsored by Stichting Professor Bakkerfons, Netherlands, and Netherlands Center for Civil Engineering Research, Codes and Specifications
(Contract F49620-88-C-0135)
(ISBN-90-9005-047-7; ETN-93-93608) Copyright Avail: CASI HC A08/MF A02

An experimental investigation into the behavior of concrete under mixed mode loading, undertaken in the light of fracture mechanics, is reported. For this purpose a unique biaxial machine which consists of two independent stiff square loading frames was built. The frames can move independent of one another along the axial and the lateral directions. Double Edge Notched (DEN) concrete plates of dimension up to 200 by 200 mm can be loaded in any combination of tension and shear in displacement control. The different DEN specimen sizes with the thickness of 50 mm were adopted. Three types of materials, namely normal concrete of 2 and 16 mm maximum aggregate size and Lytag lightweight concrete of 12 mm maximum aggregate size, were used. Seven load paths were pursued which can be classified into three broad categories: an investigation of the shear strength or stiffness of partially opened cracks; a study of the behavior of concrete specimens which were first sheared without precracking and subsequently loaded in tension; and a study of the behavior of concrete when tension and shear were acting simultaneously such that the ratio of the axial to the lateral deformation remains a constant throughout the test. The size effect law of Bazant was compared for biaxial tests with proportional load path and shows an opposite trend. This might be attributed to the difference in failure modes. From the various load path investigated, it is concluded that behavior of the specimen under biaxial loading is path dependent. The results reported can be used to tune and verify the various smeared rack models as well as micromechanical models. ESA

N93-27888*# Massachusetts Inst. of Tech., Cambridge. Space Engineering Research Center.
CONTROLLED STRUCTURES TECHNOLOGY STEERING COMMITTEE WORKSHOP
1992 249 p Workshop held in Cambridge, MA, 22-23 Jan. 1992
(Grant NAGw-1335)
(NASA-CR-192992; NAS 1.26:192992) Avail: CASI HC A11/MF A03

Viewgraphs on controlled structures technology presented at the steering committee workshop on 22-23 Jan. 1992 are included. Topics addressed include: interferometer testbed; middeck 0-gravity dynamics experiment; middeck active control experiment; multivariable identification for control; strain actuated aeroelastic control; sensor/actuator technology development; input command shaping; and other research projects. A description of the organization and committee are included. For individual titles, see N93-27889 through N93-27901.

N93-27889*# Massachusetts Inst. of Tech., Cambridge. Space Engineering Research Center.
INTERFEROMETER TESTBED: OVERVIEW AND HARDWARE SUMMARY **c74**
Andrew Nisbet *In its* Controlled Structures Technology Steering Committee Workshop 1992 10 p (For primary document see N93-27888 10-39)
Avail: CASI HC A02/MF A03

Viewgraphs on an overview and hardware summary for an interferometer testbed are presented. Topics covered include: reference mission and science requirements; science requirements derivation; reference spacecraft design summary; testbed requirements and performance metric; disturbance source and signal; and testbed architecture. CASI

N93-27890*# Massachusetts Inst. of Tech., Cambridge. Space Engineering Research Center.
FINITE ELEMENT MODEL AND IDENTIFICATION PROCEDURE
Jonathan P. How, Gary Blackwood, Eric Anderson, and Etienne Balmes *In its* Controlled Structures Technology Steering Committee Workshop 1992 18 p (For primary document see N93-27888 10-39)
Avail: CASI HC A03/MF A03

Viewgraphs on finite element model and identification procedure are presented. Topics covered include: interferometer finite element model; testbed mode shapes; finite element model update; identification procedure; shaker locations; data analysis; modal frequency and damping comparison; computational procedure; fit comparison; residue analysis; typical residues; identification/FEM residual comparison; and pathlength control using isolation mounts. CASI

N93-27891*# Massachusetts Inst. of Tech., Cambridge. Space Engineering Research Center.
CONTROL DESIGN FOR THE SERC EXPERIMENTAL TESTBEDS
Robert Jacques, Gary Blackwood, Douglas G. MacMartin, Jonathan How, and Eric Anderson *In its* Controlled Structures Technology Steering Committee Workshop 1992 12 p (For primary document see N93-27888 10-39)
Avail: CASI HC A03/MF A03

Viewgraphs on control design for the Space Engineering Research Center experimental testbeds are presented. Topics covered include: SISO control design and results; sensor and actuator location; model identification; control design; experimental results; preliminary LAC experimental results; active vibration isolation problem statement; base flexibility coupling into isolation feedback loop; cantilever beam testbed; and closed loop results. CASI

N93-27892*# Massachusetts Inst. of Tech., Cambridge. Space Engineering Research Center.
A STOCHASTIC APPROACH TO ROBUST BROADBAND STRUCTURAL CONTROL
Douglas G. MacMartin and Steven R. Hall *In its* Controlled Structures

Technology Steering Committee Workshop 1992 18 p (For primary document see N93-27888 10-39)
Avail: CASI HC A03/MF A03

Viewgraphs on a stochastic approach to robust broadband structural control are presented. Topics covered include: travelling wave model; dereverberated mobility model; computation of dereverberated mobility; power flow; impedance matching; stochastic systems; control problem; control of stochastic systems; using cost functional; Bernoulli-Euler beam example; compensator design; 'power' dual variables; dereverberation of complex structure; and dereverberated transfer function. CASI

N93-27893*# Massachusetts Inst. of Tech., Cambridge. Space Engineering Research Center.
THE MIDDECK 0-GRAVITY DYNAMICS EXPERIMENT (MODE) c29
Edward F. Crawley and Javier deLuis *In its* Controlled Structures Technology Steering Committee Workshop 1992 27 p (For primary document see N93-27888 10-39)
Avail: CASI HC A03/MF A03

Viewgraphs on the middeck 0-gravity dynamics experiment (MODE) are presented. Topics covered include: MODE flight hardware elements; MODE science objectives; MODE team; flight operations; and summary. CASI

N93-27894*# Massachusetts Inst. of Tech., Cambridge. Space Engineering Research Center.
MODE: STRUCTURAL TEST ARTICLE (STA)
Edward F. Crawley and Brett Masters *In its* Controlled Structures Technology Steering Committee Workshop 1992 12 p (For primary document see N93-27888 10-39)
Avail: CASI HC A03/MF A03

Viewgraphs on the Middeck 0-gravity Dynamics Experiment (MODE): Structural Test Article (STA) are presented. Topics covered include: MODE: structural test article motivation; hardware; sensors and actuators; experimental support module; data; preliminary results; supporting analysis program; and modeling approach. CASI

N93-27895*# Pretoria Univ. (South Africa).
MIDDECK 0-GRAVITY DYNAMICS EXPERIMENT: FLUID SLOSH EXPERIMENTS c29
Marthinus C. vanSchoor *In* MIT, Controlled Structures Technology Steering Committee Workshop 1992 27 p (For primary document see N93-27888 10-39)
Avail: CASI HC A03/MF A03

Viewgraphs on the Middeck 0-gravity Dynamics Experiment fluid slosh experiments are presented. Graphs of frequency versus planar slosh force and planar slosh force phase angle are provided for the following conditions: silicone oil in a flat bottom tank; silicon oil in a 3.1 cm diameter flat bottom tank; water in a flat bottom tank for earth; and water in a 3.1 cm diameter flat bottom tank. CASI

N93-27896*# Massachusetts Inst. of Tech., Cambridge. Space Engineering Research Center.
THE MIDDECK ACTIVE CONTROL EXPERIMENT (MACE)
David W. Miller *In its* Controlled Structures Technology Steering Committee Workshop 1992 14 p (For primary document see N93-27888 10-39)
Avail: CASI HC A03/MF A03

Viewgraphs on the Middeck Active Control Experiment (MACE) are presented. Topics covered include: program objectives; program features; flight experiment features; current activities; MACE development model lab testing; MACE test article deployed on STS middeck; and development model testing. CASI

N93-27897*# Massachusetts Inst. of Tech., Cambridge. Space Engineering Research Center.
THE MIDDECK ACTIVE CONTROL EXPERIMENT: GRAVITY AND SUSPENSION EFFECTS c29
Edward F. Crawley, H. Alexander, and Daniel Rey *In its* Controlled Structures Technology Steering Committee Workshop 1992 18 p (For primary document see N93-27888 10-39)
Avail: CASI HC A03/MF A03

Viewgraphs on the Middeck Active Control Experiment (MACE): Gravity and Suspension Effects are presented. Topics covered include: gravity and suspension influences; gravity and suspension effects on structure; gravity effects on sensors and actuators; modeling of gravity and suspension effects on structure; geometric stiffness theory and initial static deformation calculation; modeling gravity's effect on accelerometers and PMA's; application to MACE; MACE EM configuration study; and MACE DM configuration study. CASI

N93-27898*# Moscow Inst. of Aviation Technology (USSR).
THE MIDDECK ACTIVE CONTROL EXPERIMENT (MACE): IDENTIFICATION FOR ROBUST CONTROL
Valery I. Karlov *In* MIT, Controlled Structures Technology Steering Committee Workshop 1992 12 p (For primary document see N93-27888 10-39)
Avail: CASI HC A03/MF A03

Viewgraphs on identification for robust control for the Middeck Active Control Experiment (MACE) are presented. Topics covered include: identification for robust control; three levels of identification; basic elements of the approach; advantages of 'post-ID' model of uncertainty; advantages of optimization; and practical realization. CASI

N93-27899*# Massachusetts Inst. of Tech., Cambridge. Space Engineering Research Center.
STRAIN ACTUATED AEROELASTIC CONTROL
Kenneth B. Lazarus *In its* Controlled Structures Technology Steering Committee Workshop 1992 22 p Sponsored by NASA. Langley Research Center; General Dynamics Corp.; and NSF (For primary document see N93-27888 10-39)
Avail: CASI HC A03/MF A03

Viewgraphs on strain actuated aeroelastic control are presented. Topics covered include: structural and aerodynamic modeling; control law design methodology; system block diagram; adaptive wing test article; bench-top experiments; bench-top disturbance rejection: open and closed loop response; bench-top disturbance rejection: state cost versus control cost; wind tunnel experiments; wind tunnel gust alleviation: open and closed loop response at 60 mph; wind tunnel gust alleviation: state cost versus control cost at 60 mph; wind tunnel command following: open and closed loop error at 60 mph; wind tunnel flutter suppression: open loop flutter speed; and wind tunnel flutter suppression: closed loop state cost curves. CASI

N93-27900*# Massachusetts Inst. of Tech., Cambridge. Space Engineering Research Center.
SENSOR AND ACTUATOR TECHNOLOGY DEVELOPMENT c35
Eric Anderson and Nesbitt W. Hagood *In its* Controlled Structures Technology Steering Committee Workshop 1992 19 p (For primary document see N93-27888 10-39)
Avail: CASI HC A03/MF A03

Viewgraphs on sensor and actuator technology development are presented. Topics covered include: sensor and actuator placement for robustness; self-sensing actuators; and nonlinear actuation models. CASI

N93-27901*# Massachusetts Inst. of Tech., Cambridge. Space Engineering Research Center.
IMPLEMENTATION OF INPUT COMMAND SHAPING TO REDUCE VIBRATION IN FLEXIBLE SPACE STRUCTURES
Kenneth W. Chang, Warren P. Seering, and B. Whitney Rappole *In its* Controlled Structures Technology Steering Committee Workshop 1992 37 p (For primary document see N93-27888 10-39)
Avail: CASI HC A03/MF A03

Viewgraphs on implementation of input command shaping to reduce vibration in flexible space structures are presented. Goals of the research are to explore theory of input command shaping to find an efficient algorithm for flexible space structures; to characterize Middeck Active Control Experiment (MACE) test article; and to implement input shaper on the MACE structure and interpret results. Background on input shaping, simulation results, experimental results, and future work are included. CASI

N93-27944# Technische Univ., Delft (Netherlands).
ADVANCED BUCKLING ANALYSES OF BEAMS WITH ARBITRARY CROSS SECTIONS Ph.D. Thesis

Gerardus Maria vanErp 1989 131 p Sponsored by Netherlands Technology Foundation
(ISBN-9-9002808-0; ETN-93-93664) Avail: CASI HC A07/MF A02

Work performed in order to develop buckling, postbuckling and interaction analyses of beams with arbitrary cross sections is presented. A computer program was developed to determine the bifurcation loads and the associated local and distortional buckling modes of (perfect) beams with arbitrary cross sections. The influence of prebuckling deformations was neglected in this computer program. These modes were used to determine the postbuckling and mode interaction behavior of the beams, with the aid of Koiter's general stability theory. In order to study the effects of large in-plane deflections in the case of long beams, a general nonlinear beam theory was derived, which is applicable to beams that undergo arbitrary large deflections and rotations. Based on this theory, a computer program was developed in order to determine the bifurcation load of these beams. In addition to this computer program, a second computer program was developed to determine all the geometric properties, which play a role in this nonlinear beam theory. ESA

N93-28059# Westinghouse Hanford Co., Richland, WA.
STRESS ANALYSIS AND EVALUATION OF A RECTANGULAR PRESSURE VESSEL
M. A. Rezvani, H. H. Ziada, and M. S. Shurrab (Westinghouse Savannah River Co., Aiken, SC.) Oct. 1992 6 p Presented at the 1993 American Society of Mechanical Engineers (ASME) National Design Engineering Conference, Chicago, IL, 7-11 Mar. 1993
(Contract DE-AC06-87RL-10930)
(DE93-004990; WHC-SA-1619; WSRC-MS-92-316; CONF-930361-2) Avail: CASI HC A02/MF A01

This study addresses structural analysis and evaluation of an abnormal rectangular pressure vessel, designed to house equipment for drilling and collecting samples from Hanford radioactive waste storage tanks. It had to be qualified according to ASME boiler and pressure vessel code, section 8; however, it had the cover plate bolted along the long face, a configuration not addressed by the code. Finite element method was used to calculate stresses resulting from internal pressure; these stresses were then used to evaluate and qualify the vessel. Fatigue is not a concern; thus, it can be built according to section 8, division 1 instead of division 2. Stress analysis was checked against the code. A stayed plate was added to stiffen the long side of the vessel. DOE

N93-28161# Lawrence Livermore National Lab., CA.
MODELING THE BEHAVIOR OF MATERIALS
M. L. Wilkins Mar. 1993 81 p
(Contract W-7405-eng-48)
(DE93-010483; UCRL-ID-113198) Avail: CASI HC A05/MF A01

The first requirement in the calculation of problems in mechanics is a formulation of the material behavior. The material description should include elastic, elastic-plastic, and hydrodynamic flow. The literature includes many complicated forms to describe material behavior. However, since numerical techniques are considered here, the equations of motion are completely independent of equations that describe material behavior, and any mathematical form may be used. The objective of the material models is to provide a theoretical description applicable to a wide class of practical problems, but using simple idealizations of the outstanding features of the real phenomena. The problem at hand pertains to metal plasticity, so details for describing elastic-plastic material are presented. Formulation of this problem provides framework for sophisticated descriptions of material behavior. The mathematics has been organized so that departure can be made from the elastic perfectly plastic model without any change to the basic program that solves the equations of mechanics. Some of the material descriptions presented include dynamic yielding based on dislocation theory, work hardening, pressure, and temperature effects on material strength. Incremental plasticity is used so that large deformations with rotation are modeled. DOE

N93-28167*# Massachusetts Inst. of Tech., Cambridge. Space Engineering Research Center.
THE 3RD ANNUAL CONTROLLED STRUCTURES TECHNOLOGY SYMPOSIUM
1 Jul. 1991 251 p Symposium held in Cambridge, MA, 1 Jul. 1991
(Grant NAGw-1335)
(NASA-CR-192993; NAS 1.26:192993) Avail: CASI HC A12/MF A03

Viewgraphs of presentations at the Controlled Structures Technology (CST) MIT Space Engineering Research Center 3rd Annual Symposium are included. Topics covered include optical interferometer testbed; active impedence matching of complex structural systems; application of CST to adaptive optics; middeck 0-G dynamics Experiment (MODE); inhibiting multiple mode vibration in controlled flexible systems; the middeck active control experiment (MACE); robust control for uncertain structures; cost averaging techniques for robust structural control; and intelligent structures technology. For individual titles, see N93-28168 through N93-28176.

N93-28168*# Massachusetts Inst. of Tech., Cambridge.
OPTICAL INTERFEROMETER TESTBED **c74**
Gary H. Blackwood *In its* The 3rd Annual Controlled Structures Technology Symposium 1 Jul. 1991 26 p (For primary document see N93-28167 10-39)
Avail: CASI HC A03/MF A03

Viewgraphs on optical interferometer testbed presented at the MIT Space Research Engineering Center 3rd Annual Symposium are included. Topics covered include: space-based optical interferometer; optical metrology; sensors and actuators; real time control hardware; controlled structures technology (CST) design methodology; identification for MIMO control; FEM/ID correlation for the naked truss; disturbance modeling; disturbance source implementation; structure design: passive damping; low authority control; active isolation of lightweight mirrors on flexible structures; open loop transfer function of mirror; and global/high authority control. CASI

N93-28169*# Massachusetts Inst. of Tech., Cambridge.
ACTIVE IMPEDANCE MATCHING OF COMPLEX STRUCTURAL SYSTEMS
Douglas G. MacMartin, David W. Miller, and Steven R. Hall *In its* The 3rd Annual Controlled Structures Technology Symposium 1 Jul. 1991 19 p (For primary document see N93-28167 10-39)
Avail: CASI HC A03/MF A03

Viewgraphs on active impedance matching of complex structural systems are presented. Topics covered include: traveling wave model; dereverberated mobility model; computation of dereverberated mobility; control problem: optimal impedance matching; H2 optimal solution; statistical energy analysis (SEA) solution; experimental transfer functions; interferometer actuator and sensor locations; active strut configurations; power dual variables; dereverberation of complex structure; dereverberated transfer function; compensators; and relative power flow. CASI

N93-28170*# Massachusetts Inst. of Tech., Cambridge.
THE APPLICATION OF CONTROLLED STRUCTURES TECHNOLOGY TO ADAPTIVE OPTICS
Eric H. Anderson and Jonathan P. How *In its* The 3rd Annual Controlled Structures Technology Symposium 1 Jul. 1991 27 p (For primary document see N93-28167 10-39)
Avail: CASI HC A03/MF A03

Viewgraphs on the application of controlled structures technology (CST) to adaptive optics are presented. Topics covered include: a typical large optical system (LDR); overview of current optical programs; typical adaptive optics system; actuation approaches for deforming a mirror; control approach comparison; control structure interaction (CSI) control bandwidth limitations; applications of CST concepts to optics; distributed control approaches; quasistatic error correction; low authority control (LAC); and high authority control (HAC) design methodology. CASI

N93-28171*# Massachusetts Inst. of Tech., Cambridge.
MIDDECK 0-GRAVITY DYNAMICS EXPERIMENT (MODE) **c29**
Marthinus C. vanSchoor *In its* The 3rd Annual Controlled Structures Technology Symposium 1 Jul. 1991 23 p (For primary document see N93-28167 10-39)
Avail: CASI HC A03/MF A03

Viewgraphs on Middeck 0-gravity Dynamics Experiment (MODE) are presented. Topics covered include: MODE and its rationale; program objectives; truss structures; contained fluids; experimental design for structures and contained fluids; modeling approach; and progress to date. CASI

N93-28172*# Massachusetts Inst. of Tech., Cambridge.
INHIBITING MULTIPLE MODE VIBRATION IN CONTROLLED FLEXIBLE SYSTEMS
James M. Hyde, Kenneth W. Chang, and Warren P. Seering *In its* The 3rd Annual Controlled Structures Technology Symposium 1 Jul. 1991 19 p (For primary document see N93-28167 10-39)
Avail: CASI HC A03/MF A03

Viewgraphs on inhibiting multiple mode vibration in controlled flexible systems are presented. Topics covered include: input pre-shaping background; developing multiple-mode shapers; Middeck Active Control Experiment (MACE) test article; and tests and results. CASI

N93-28173*# Massachusetts Inst. of Tech., Cambridge.
THE MIDDECK ACTIVE CONTROL EXPERIMENT (MACE)
David W. Miller *In its* The 3rd Annual Controlled Structures Technology Symposium 1 Jul. 1991 24 p (For primary document see N93-28167 10-39)
Avail: CASI HC A03/MF A03

Viewgraphs on the Middeck Active Control Experiment (MACE) are presented. Topics covered include: science program objectives and rationale; science requirements; capturing the essential physics; science development approach; development model hardware; development model test plan; and flight hardware and operations. CASI

N93-28174*# Massachusetts Inst. of Tech., Cambridge.
ROBUST CONTROL FOR UNCERTAIN STRUCTURES
Joel Douglas and Michael Athans *In its* The 3rd Annual Controlled Structures Technology Symposium 1 Jul. 1991 17 p (For primary document see N93-28167 10-39)
Avail: CASI HC A03/MF A03

Viewgraphs on robust control for uncertain structures are presented. Topics covered include: robust linear quadratic regulator (RLQR) formulas; mismatched LQR design; RLQR design; interpretations of RLQR design; disturbance rejection; and performance comparisons: RLQR vs. mismatched LQR. CASI

N93-28175*# Massachusetts Inst. of Tech., Cambridge.
COST AVERAGING TECHNIQUES FOR ROBUST CONTROL OF FLEXIBLE STRUCTURAL SYSTEMS **c83**
Nesbitt W. Hagood and Edward F. Crawley *In its* The 3rd Annual Controlled Structures Technology Symposium 1 Jul. 1991 22 p (For primary document see N93-28167 10-39)
Avail: CASI HC A03/MF A03

Viewgraphs on cost averaging techniques for robust control of flexible structural systems are presented. Topics covered include: modeling of parameterized systems; average cost analysis; reduction of parameterized systems; and static and dynamic controller synthesis. CASI

N93-28176*# Massachusetts Inst. of Tech., Cambridge.
INTELLIGENT STRUCTURES TECHNOLOGY
Edward F. Crawley *In its* The 3rd Annual Controlled Structures Technology Symposium 1 Jul. 1991 26 p (For primary document see N93-28167 10-39)
Avail: CASI HC A03/MF A03

Viewgraphs on intelligent structures technology are presented. Topics covered include: embedding electronics; electrical and mechanical compatibility; integrated circuit chip packaged for embedding; embedding devices within composite structures; test of embedded circuit in G/E coupon; temperature/humidity/bias test; single-chip microcomputer control experiment; and structural shape determination. CASI

N93-28313# Oak Ridge National Lab., TN.
CRACK PROPAGATION IN NiAl AND FeAl
J. H. Schneibel, M. G. Jenkins, and P. J. Maziasz 1992 6 p Presented at the 16th Material Research Society International Symposium on the Scientific Basis for Nuclear Waste Management Fall Meeting, Boston, MA, 30 Nov. - 5 Dec. 1992
(Contract DE-AC05-84OR-21400)
(DE93-007244; CONF-921101-84) Avail: CASI HC A02/MF A01

The crack-propagation behavior and fracture toughness at room temperature of extruded and heat-treated NiAl and FeAl were examined by testing chevron-notched, three-point flexural specimens at constant crosshead speeds. In Ni-50 at. % Al, sudden load drops occurred repeatedly, indicating run-arrest crack propagation. The fracture resistance was not found to depend on the crosshead speed. Iron additions of up to 1 at. % and boron additions of 0.01 at. % did generally not improve the fracture toughness. By contrast, crack propagation in Fe-40 at. % Al occurred in a stable manner. In agreement with the environmental sensitivity of this intermetallic alloy, fracture resistance did depend on the crack-propagation velocity, indicative of the kinetic nature of this process. While the crack-growth resistance of iron aluminides was reduced by changing the aluminum content from 40 to 45 at. %, it was increased significantly by small additions of boron. DOE

N93-28363# New Hampshire Univ., Durham. Dept. of Mechanical Engineering.
EFFECT OF FRACTURE SURFACE ROUGHNESS ON SHEAR CRACK GROWTH
Todd S. Gross, David W. Watt, and Daniel A. Mendelsohn (Ohio State Univ., Columbus.) Dec. 1992 27 p
(Contract DE-FG02-90ER-45433)
(DE93-011047; DOE/ER-45433/2) Avail: CASI HC A03/MF A01

A model of fracture surface interference for Mode 1 fatigue crack profiles was developed and evaluated. The force required to open the crack faces is estimated from point contact expressions for the Mode 1 stress intensity factor. Force transfer across contacting asperities is estimated and used to calculate Mode 2 resistance stress intensity factor (applied factor is sum of effective and resistance factors). Electro-optic holographic interferometry was used to measure 3-D displacement field around a Mode 1 fatigue pre-crack in Al loaded in Mode 2 shear. Induced Mode 1 crack face displacements were greater than Mode 2 displacements. Plane stress shear lip caused displacement normal to surface as the crack faces are displaced. Algorithms are being developed to track the displacements associated with the original coordinate system in the camera. A 2-D boundary element method code for mixed mode 1 and 2 loading of a rough crack (sawtooth asperity model) has been completed. Addition of small-scale crack tip yielding and a wear model are completed and underway, respectively. DOE

N93-28432# Lawrence Livermore National Lab., CA.
NEAR THRESHOLD FATIGUE TESTING
D. C. Freeman and M. J. Strum Jan. 1993 14 p
(Contract W-7405-eng-48)
(DE93-009069; UCRL-ID-112608) Avail: CASI HC A03/MF A01

Measurement of the near-threshold fatigue crack growth rate (FCGR) behavior provides a basis for the design and evaluation of components subjected to high cycle fatigue. Typically, the near-threshold fatigue regime describes crack growth rates below approximately 10(exp -5) mm/cycle (4 x 10(exp -7) inch/cycle). One such evaluation was recently performed for the binary alloy U-6Nb. The procedures developed for this evaluation are described in detail to provide a general test method for near-threshold FCGR testing. In particular, techniques for high-resolution measurements of crack length performed in-situ through a direct current, potential drop (DCPD) apparatus, and a method which eliminates crack closure effects through the use of loading cycles with constant maximum stress intensity are described. DOE

N93-27182 Tel-Aviv Univ. (Israel). Fracture Mechanics Lab.
APPLICATION OF THE CYCLIC J-INTEGRAL TO FATIGUE CRACK PROPAGATION
Yehuda Volpert and Leslie Banks-Sills *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 136-143 (For primary document see N93-27166 10-01)
Copyright Avail: Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel

N93-27184 Israel Military Industries, Ramat-Hasharon.
STABILITY OF SINGLE LAYER COMPOSITE CYLINDERS SUBJECTED TO LATERAL PRESSURE: NUMERICAL APPROACH
M. A. Mikulinsky *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 149-153 (For primary document see N93-27166 10-01)

Copyright Avail: Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel

N93-27213 Rafael Armament Development Authority, Haifa (Israel). Structural Analysis Group.
OPTIMIZATION METHOD IN NONLINEAR ANALYSIS OF A CIRCULAR ROTATING CLUSTER PACKAGE
A. Levin *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 392-397 (For primary document see N93-27166 10-01)
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N93-27559*# Stanford Univ., CA. Dept. of Mechanical Engineering.
SIX DEGREES OF FREEDOM VIBRATION ISOLATION USING ELECTROMAGNETIC SUSPENSION
Sang-il Lee, Daniel B. DeBra, Peter F. Michelson, Robert C. Taber, and John C. Price *In* NASA. Langley Research Center, Magnetic Suspension Technology Workshop 1993 p 75-84 (For primary document see N93-27554 10-18)
(Grants NSF PHY-85-13525; NSF PHY-85-15856)
Avail: CASI HC A02/MF A03

N93-27564*# Aura Systems, Inc., Los Angeles, CA.
MAGNETIC GIMBAL PROOF-OF-CONCEPT HARDWARE PERFORMANCE RESULTS
Keith O. Stuart *In* NASA. Langley Research Center, Magnetic Suspension Technology Workshop 1993 p 163-174 (For primary document see N93-27554 10-18)
Avail: CASI HC A03/MF A03

42 GEOSCIENCES (GENERAL)

N93-27421# National Museum of Natural History, Washington, DC.
ATOLL RESEARCH BULLETIN NUMBERS 355-364: 40TH ANNIVERSARY ISSUE
D. R. Stoddart, F. R. Fosberg, M. M. Littler, I. G. Macintyre, and J. I. Tracey May 1992 453 p
(PB93-169654) Avail: CASI HC A20/MF A04

The contents are as follows: F. Raymond Fosberg and the Atoll Research Bulletin 1951-1991; Environmental, Variability and Environmental Extremes as Factors in Island Ecosystems; Nukutipipi Atoll, Tuamotu Archipelago: Geomorphology, Land and Marine Flora and Fauna and Interrelationships; Vegetation History of Washington Island (Teraina), Northern Line Islands; Studies of Soils and Plants in Northern Marshall Islands; Occurrence of Phosphate Rock and Associated Soils in Tuvalu, Central Pacific; Batiri Kei Baravi: The Ethnobotany of Pacific Island Coastal Plants; Substrate Specificity and Episodic Catastrophe: Constraints on the Insular Plant Geography of Suwarrow Atoll, Northern Cook Islands; Secondary Plant Cover on Upland Slopes Marquesas Islands, French Polynesia; and Seagrass Nets. NTIS

43 EARTH RESOURCES AND REMOTE SENSING

Includes remote sensing of earth resources by aircraft and spacecraft; photogrammetry; and aerial photography.

For instrumentation see *35 Instrumentation and Photography.*

N93-26615# Los Alamos National Lab., NM.
DUAL USE OF DISTRIBUTED REMOTE SENSING SATELLITES
G. H. Canavan Mar. 1993 8 p
(Contract W-7405-eng-36)
(DE93-008852; LA-12502-MS) Avail: CASI HC A02/MF A01

Satellites can serve both defense and the environment, simultaneously monitoring preparations for aggression, the environment, pollution, and natural disasters. These applications have been discussed extensively in international meetings, which have produced specific projects for cooperation and growing acceptance of dual-use concepts. DOE

N93-26624# Westinghouse Hanford Co., Richland, WA.
SURVEY OF FIBER-OPTIC SENSOR FOR REMOTE SENSING IN RADIOLOGICALLY AND CHEMICALLY HARSH ENVIRONMENTS
R. S. Addleman, B. A. Crawford, S. J. Mech, G. L. Troyer, and R. A. Greenwell (Science and Engineering Associates, Inc., San Diego, CA.) Sep. 1992 13 p Presented at the International Society for Optical Engineering (SPIE) Meeting, Boston, MA, 8-11 Sep. 1992 Revised
(Contract DE-AC06-87RL-10930)
(DE93-004998; WHC-SA-1411-Rev-2; CONF-9209184-7-Rev-2) Avail: CASI HC A03/MF A01

The need for suitable remote sensors in highly radioactive defense waste storage tanks is discussed. The harsh radiological and chemical tank environment precludes the use of standard sensors because of the need for intrinsically safe systems. Potential sensor systems based on fiber-optics technologies suitable for hardening to the tank environment are identified. The need for certification standards for this type of environment is also discussed. DOE

N93-27053# Agricultural Research Service, Beltsville, MD.
GRAMI: A CROP GROWTH MODEL THAT CAN USE REMOTELY SENSED INFORMATION
Stephen J. Maas (Agricultural Research Service, Weslaco, TX.) Oct. 1992 83 p
(PB93-162014; ARS-91) Avail: CASI HC A05/MF A01

The document describes GRAMI, a model designed to demonstrate the use of remotely sensed information in simulating the growth and yield of grain crops. An important objective continued to describe a numerical technique for using remotely sensed information in the model. Here, 'remotely sensed information' refers to a quantification of some crop attribute (such as biomass or leaf area index) obtained through noncontact methods, usually involving the measurement of electromagnetic radiation in specific wavelengths reflected by the crop canopy. The numerical technique in GRAMI was designed to be independent of the source of the remotely sensed data. Field data obtained through destructive sampling can also be used in place of remotely sensed data. NTIS

N93-27054# National Oceanic and Atmospheric Administration, Boulder, CO. Wave Propagation Lab.
RADAR IMAGING OF THE SEA SURFACE USING DIFFERENT POLARIZATIONS: COMPARISON BETWEEN THEORY AND EXPERIMENT
Valery U. Zavorotny (Colorado Univ., Boulder.) Jan. 1993 35 p
(PB93-161768; NOAA-TM-ERL-WPL-228) Avail: CASI HC A03/MF A01

Recently obtained polarimetric radar images of ocean areas are considered. The first attempt to find a possible explanation for drastic differences between two different polarizations is made. At the same time, a summary of the existing theoretical models for radar scattering and imaging is presented. Various theoretical approaches are examined in order to understand the origin of the polarization peculiarities. It is found that these images cannot be explained with the two-scale Bragg model. New approaches reviewed here present only a collection of physical mechanisms that should be synthesized in a consistent way. Another, more robust theory of electromagnetic wave scattering on the real ocean surface is desirable for radar image interpretation. NTIS

N93-27066# Congress of the United States, Washington, DC.
REMOTELY SENSED DATA FROM SPACE: DISTRIBUTION, PRICING, AND APPLICATIONS. AN OTA BACKGROUND PAPER
Jul. 1992 29 p
Avail: CASI HC A03/MF A01

This year Congress faces important decisions about the future course of the Landsat land remote sensing satellite program and the experiment with commercialization that began in 1984. A concensus is emerging within the government that Landsat 7 will be funded and managed by the public sector. While giving greater assurance that Landsat data will continue to be available for scientists and other uses of the data, returning Landsat operations to the public sector creates a new set of problems. Users of Landsat data expect the data to find increased use among government agencies for a variety of beneficial applications, including environmental monitoring, surface change detection, and evaluation of resources. Many hope the data will also be the basis for a diverse and profitable U.S. industry, which enhances and sells data products to a range of users in

the United States and abroad. Policies adopted to govern the pricing and distribution of Landsat data will affect: (1) how much data are available, for which applications; (2) how the ultimate costs of providing land remote sensing data are divided between the public and private sectors; (3) how the public costs and benefits of remotely sensed data are divided among federal agencies; (4) the extent to which private firms using Landsat data benefit from the system; (5) the competitive prospects of foreign systems, and the terms and conditions under which similar data produced by foreign systems are available to U.S. public and private sectors; (6) the prospect of future U.S. privately financed and operated systems intended to serve 'niche' markets; (7) the pace of technological improvement in geographic information systems and the character of new applications; and (8) technological development of future Landsat-type satellites. This short background paper summarizes the discussion concerning data pricing and distribution from a one-day workshop convened by OTA on May 20, 1992.
Derived from text

N93-27072*# JJM Systems, Inc., Arlington, VA.
AN EXPERT SYSTEM SHELL FOR INFERRING VEGETATION CHARACTERISTICS: CHANGES TO THE HISTORICAL COVER TYPE DATABASE (TASK F)
26 May 1993 39 p
(Contract NAS5-30127)
(NASA-CR-193067; NAS 1.26:193067; C93120-U-2R05) Avail: CASI HC A03/MF A01

All the options in the NASA VEGetation Workbench (VEG) make use of a database of historical cover types. This database contains results from experiments by scientists on a wide variety of different cover types. The learning system uses the database to provide positive and negative training examples of classes that enable it to learn distinguishing features between classes of vegetation. All the other VEG options use the database to estimate the error bounds involved in the results obtained when various analysis techniques are applied to the sample of cover type data that is being studied. In the previous version of VEG, the historical cover type database was stored as part of the VEG knowledge base. This database was removed from the knowledge base. It is now stored as a series of flat files that are external to VEG. An interface between VEG and these files was provided. The interface allows the user to select which files of historical data to use. The files are then read, and the data are stored in Knowledge Engineering Environment (KEE) units using the same organization of units as in the previous version of VEG. The interface also allows the user to delete some or all of the historical database units from VEG and load new historical data from a file. This report summarizes the use of the historical cover type database in VEG. It then describes the new interface to the files containing the historical data. It describes minor changes that were made to VEG to enable the externally stored database to be used. Test runs to test the operation of the new interface and also to test the operation of VEG using historical data loaded from external files are described. Task F was completed. A Sun cartridge tape containing the KEE and Common Lisp code for the new interface and the modified version of the VEG knowledge base was delivered to the NASA GSFC technical representative.
Author (revised)

N93-27288*# National Aeronautics and Space Administration, Washington, DC.
EOS/AMSU-A NASA/AEROJET INTERFACE MEETING
1993 138 p Meeting held 11 May 1993 Prepared in cooperation with GenCorp Aerojet, Sacramento, CA
(NASA-TM-108234; NAS 1.15:108234) Avail: CASI HC A07/MF A02

The topics are presented in viewgraph form and include the following: an instrument and changes overview; mechanical requirements; thermal requirements; electrical command and data handling; contamination; software; integration and test; and environmental requirements assessments.
CASI

N93-27368# Technische Univ., Delft (Netherlands). Faculty of Geodetic Engineering.
SOME ASPECTS OF A 3-DIMENSIONAL REFERENCE SYSTEM FOR SURVEYING IN THE NETHERLANDS: QUALITY ANALYSIS OF GPS PHASE OBSERVATIONS
A. J. M. Koesters Feb. 1992 146 p Sponsored by Cadastral Service, Apeldoorn, Netherlands, and Rijkswaterstaat, Delft, Netherlands
(Rept-92.1; ETN-93-93268) Avail: CASI HC A07/MF A02

The underlying ideas of how the research and the strategy concerning the Global Positioning System (GPS) was developed are outlined. The reliability of GPS networks is discussed. A review of quality control theory in geodetic networks and its meaning for geodetic reference frames in practice is given. The structure of the GPS phase observables and a method to process them are outlined. This method will include a strategy to give reliability description of GPS networks. Results of planning computations are presented as an illustration of this strategy. The detectability and influence of some important error sources are considered.
ESA

N93-27504 Ohio State Univ., Columbus.
DIGITAL MAPPING INFERENCE MECHANISM: A PROCESS OF KNOWLEDGE EXTRACTION AND HYPOTHESES EVALUATION Ph.D. Thesis
Dafer Ali Algarni 1992 141 p
Avail: Univ. Microfilms Order No. DA9307714

Image interpretation is a complex task which confuses not only the machine vision but also that of human beings. The ideal case of interpretation is to understand the process followed by humans when interpreting image features and direct the machine to do the same task i.e., do it the human way. However, this approach seems very difficult since learning the human way does not seem possible. It is clear that quantitative parameters pose less difficulty in today's technology. On the other hand, the qualitative parameters are more difficult to implement or manipulate. It is my understanding and belief that the qualitative parameters are of more importance than that of quantitative parameters in mapping domain. In other words, the quantitative parameters should be involved in processing and manipulation under the control of qualitative ones and not vice versa. This concept manifests itself when an image interpretation problem is the task to be solved. Thus the need is raised for some qualitative parameters and vocabulary that enable image analysts to handle properly the image understanding task. Scientists in photogrammetry were able to develop very sophisticated mechanisms that perform many tasks of geometrical characteristics. However, the problem of recognizing image features has made less progress and achievement in most studies. This is the main concern and problem that was treated in this study. The image feature recognition is not a straightforward problem that can be solved in one big step. Reasoning with the image data is an approach that may yield the most accurate result. Therefore, there are not many alternatives besides hypothesizing about features' existence and trying to confirm or falsify certain propositions based on the extracted data and the hypotheses' significance. The theory of Generic Task (GT) is adapted for this research in which the image interpretation task is divided into sub-tasks to facilitate the evaluation process and enable understanding of the nature of the problem. I found this technique applicable to image feature recognition due, in part, to the possibility of representing the image knowledge without losing the knowledge's value or significance. Following the GT approach, an inference mechanism for image interpretation is proposed and discussed. Abduction, the inference to the best explanation, model for image feature recognition is developed for the first time and found to be applicable. Furthermore, an implemented system is presented and some results are documented.
Dissert. Abstr.

N93-27702# Beleidscommissie Remote Sensing, Delft (Netherlands).
DESKTOP PUBLISHING IN REMOTE SENSING [DESKTOP PUBLISHING EN REMOTE SENSING]
Aug. 1992 27 p In DUTCH Prepared in cooperation with DHV Raadgevend Ingenieursbureau B.V., Amersfoort, Netherlands Original contains color illustrations
(BCRS-92-15; ISBN-9-05-411058-9; TD-92-2902; ETN-93-93757) Avail: CASI HC A03/MF A01

A study on the use of Desktop Publishing (DTP) in remotely sensed image processing is presented. Two maps based on a satellite image taken by LANDSAT 5 are given as an example of application. The image was geometrically corrected and transformed to the map projection used for Dutch topographical maps. This involved the use of an image processing software package, with which subsequently the colors were modified to create a 'true color' image: the observer seems to look at the Earth directly from the satellite. Classification of land use resulted in a land use

map. By means of digitizing tables, analog maps were converted to digital data to obtain the topographical data such as waterways and roads. Together with the land use map and the space map, these results were read into a DTP software package. Compared to the image processing software, this program offers more possibilities for an interactively processed layout of a cartographically sound output. Four color divided photographic films were made, using a postscript output file. These films are ready for use by the printer. ESA

N93-27942# Rome Univ. (Italy). Dipt. di Fisica.
BETELGUEUSE '90 CAMPAIGN [CAMPAGNA BETELGEUSE '90]
Francesco Bignami, Roberta Serravall, and Stefania Sparnocchia 23 Jul. 1990 45 p In ITALIAN
(Preprint-751; ETN-93-93644) Avail: CASI HC A03/MF A01

The results of hydrological measurements taken during the BETELGUESE '90 campaign between 24 Feb. - 12 Mar. 1990 to study the circulation in the central Tyrrhenian Sea are presented. A general map of the hydrological stations of the BETELGEUSE '90 campaign and a bathymetric map of the work area are given. The following are then presented: maps of potential temperature, salinity and potential densities at various depths; Theta-S graphs of the BETELGEUSE '90 hydrological stations; isopicne curves; superficial temperatures of the western Mediterranean in mid February. ESA

N93-27943# Rome Univ. (Italy). Dipt. di Fisica.
BOOTES '90 CAMPAIGN [CAMPAGNA BOOTES '90]
Francesco Bignami, Arrigo Caserta, Roberta Serravall, and Stefania Sparnocchia 22 Nov. 1990 106 p In ITALIAN
(Preprint-768; ETN-93-93658) Avail: CASI HC A06/MF A02

The results of hydrological measurements made during the BOOTES '90 campaign between 21-30 Aug. 1990 to study the circulation in the central Tyrrhenian Sea are presented. A general map of the hydrological stations of the BOOTES '90 campaign, a map of the hydrological stations situated in the area of the Island of Pontine (BOOTES '90 campaign), and a bathymetric map of the central Tyrrhenian overlooking the Lazio coast, are given. The following are then presented: maps of potential temperature, salinity and potential densities at various depths; Theta-S graphs of the hydrological stations; isopicne curves; power spectra of the fixed height temperature measurements; superficial temperatures of the western Mediterranean in mid August. ESA

N93-28417*# Scripps Institution of Oceanography, La Jolla, CA.
STUDY OF ATMOSPHERIC AND BIDIRECTIONAL EFFECTS ON SURFACE REFLECTANCE AND VEGETATION INDEX TIME SERIES: APPLICATION TO NOAA AVHRR AND PREPARATION FOR FUTURE SPACE MISSIONS Final Report
Robert Frouin 14 Jun. 1993 46 p
(Grant NAGw-1968)
(NASA-CR-193158; NAS 1.26:193158) Avail: CASI HC A03/MF A01

The objectives of the investigation, namely 'to characterize the atmospheric and directional effects on surface reflectance and vegetation index using the First International Satellite Cloud Climatology Project (ISLCSP) Field Experiment (FIFE) data set, develop new algorithms to obtain better Advanced Very High Resolution Radiometer (AVHRR) indices, and define possible improvements for future satellite missions', were addressed in three separate, yet complementary studies. First, it was shown, from theoretical calculations, that visible and near infrared reflectances combined linearly at optimum (one or two) viewing angles relate linearly to the fraction of photosynthetically available radiation absorbed by plants, f(sub par), can be used independently of the type of foliage and substrate, eliminate the effects of sub-pixel spatial heterogeneity, and improve the accuracy of the f(sub par) estimates when compared to the Normalized Difference Vegetation Index, NDVI. Second, it was demonstrated that NDVI, even though it is not a linear combination of radiances or reflectances, can be spatially integrated without significant loss of information from scales of 300 to 1000 m. Third, AVHRR visible and near-infrared reflectances over the FIFE site, separating temporal and bidirectional components and determining the model parameters through an original iterative scheme was successfully modeled. It appears that NDVI generated from the top-of-atmosphere reflectances normalized by the bidirectional effects (as determined in the scheme) is a better vegetation index than maximum NDVI. Details about the three studies are presented. Author (revised)

N93-27179 Technion - Israel Inst. of Tech., Haifa. Faculty of Aerospace Engineering.
MERGING SPARSE OPTICAL FLOW AND EDGE CONNECTIVITY BETWEEN IMAGE FEATURES: A REPRESENTATION SCHEME FOR 2-D DISPLAY OF SCENE DEPTH
J. Waldmann and S. J. Merhav *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 107-115 (For primary document see N93-27166 10-01)
Copyright Avail: Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel

44 ENERGY PRODUCTION AND CONVERSION

Includes specific energy conversion systems, e.g., fuel cells; global sources of energy; geophysical conversion; and windpower.

For related information see also *07 Aircraft Propulsion and Power, 20 Spacecraft Propulsion and Power,* and *28 Propellants and Fuels.*

N93-26628# Arkansas Univ., Fayetteville.
BIOLOGICAL CONVERSION OF SYNTHESIS GAS
K. T. Klasson, R. Basu, E. R. Johnson, E. C. Clausen, and J. L. Gaddy Mar. 1992 92 p
(Contract DE-FG21-90MC-27225)
(DE93-008552; DOE/MC-27225/3258) Avail: CASI HC A05/MF A01

Mass transfer and kinetic studies were carried out for the Rhodospirillum rubrum and Chlorobium thiosulfatophilum bacterial systems. R. rubrum is a photosynthetic anaerobic bacterium which catalyzes the biological water gas shift reaction: CO + H2O yields CO2 + H2. C. thiosulfatophilum is also a H2S and COS to elemental sulfur. The growth of R. rubrum may be satisfactorily carried out at 25 and 30 C, while CO uptake and thus the conversion of CO best occurs at temperatures of either 30, 32 or 34 C. The rate of conversion of COs and H2O to CO2 and H2S may be modeled by a first order rate expression. The rate constant at 30 C was found to be 0.243 h(sup -1). The growth of C. thiosulfatophilum may be modeled in terms of incoming light intensity using a Monod equation: mu = (sub 351) + I(sub o)/(sup 0.152)I(sub o). Comparisons of the growth of R. rubrum and C. thiosulfatophilum shows that the specific growth rate of C. thiosulfatophilum is much higher at a given light intensity. DOE

N93-26634# Gas Research Inst., Chicago, IL.
POLICY IMPLICATIONS OF THE GRI BASELINE PROJECTION OF US ENERGY SUPPLY AND DEMAND TO 2010, 1993
Jan. 1993 22 p See also PB93-165744 and PB92-142553 LIMITED REPRODUCIBILITY: More than 20% of this document may be affected by microfiche quality
(PB93-165751; GRI-93/0032) Avail: CASI HC A03

The paper summarizes the 1993 edition of the Gas Research Institute (GRI) Baseline Projection of U.S. Energy Supply and Demand and presents the implications of the projections that are important for GRI research and development planning and the gas industry. The survey of supply and demand considerations is followed by a breakdown of energy demand by type of fuel, by consumption sector, and by service application. Gas supply and prices are analyzed in terms of two scenarios: a constrained energy demand scenario, and an optimistic scenario. Tables and charts accompany the summary. NTIS

N93-27107# Department of Energy, Morgantown, WV. Energy Technology Center.
STRATEGIC PLANNING FOR MOLTEN CARBONATE FUEL CELL DEVELOPMENT AND COMMERCIALIZATION
M. C. Williams and M. J. Mayfield 1993 6 p Presented at the Fuel Cell Seminar, Tucson, AZ, 29 Nov. - 2 Dec. 1992
(DE93-009156; DOE/METC-C/93/7056; CONF-921114-5) Avail: CASI HC A02/MF A01

The molten carbonate fuel cell (MCFC), a high-temperature fuel cell, is a promising energy conversion product for generating electricity. Natural gas availability appears to play a key role in MCFC commercialization; natural gas MCFC and Integrated Gasification MCFC (IGMCFC) are emerging power generation options that are responsive to requirements of Clean Air Act amendments and to guidance in National Energy Strategy. Goal of

DOE IGMCFC program is to demonstrate the commercial readiness of this technology by the year 2010. DOE MCFC development objectives and planned activities are outlined. DOE

N93-27108# Sandia National Labs., Albuquerque, NM.
SILICON-FILM(TM) ON CERAMIC SOLAR CELLS
R. B. Hall, C. Bacon, V. DiReda, D. H. Ford, A. E. Ingram, S. M. Lampo, J. A. Rand, T. R. Ruffins, and A. M. Barnett Feb. 1993 35 p Prepared in cooperation with AstroPower, Inc., Newark, DE
(Contract DE-AC04-76DP-00789)
(DE93-009608; SAND-92-7011) Avail: CASI HC A03/MF A01

The Silicon-Film(trademark) design achieves high performance through the use of a thin silicon layer. Optimally designed thin crystalline solar cells (less than 50 microns thick) have performance advantages over conventional thick devices. The enhancement in performance requires the incorporation of back-surface passivation and light trapping. The high-performance Silicon-Film(trademark) design employs a metallurgical barrier between the low-cost substrate and the thin silicon layer. The properties of the metallurgical barrier must be engineered to implement specific device requirements, such as high back-surface reflectivity. Recent advances in process development are described here. DOE

N93-27227# Technische Univ., Eindhoven (Netherlands). Electromechanics and Power Electronics Group.
A PWM CURRENT-SOURCE INVERTER FOR INTERCONNECTION BETWEEN A PHOTOVOLTAIC ARRAY AND THE UTILITY LINE
S. W. H. deHaan Jul. 1991 85 p
(EUT-91-E-253; ISBN-9-06-144253-2; ETN-93-93158) Avail: CASI HC A05/MF A01

A three phase transformerless power electronic conversion system is used as an interface between a photovoltaic array and the utility line. Because of the absence of a power transformer, and because of a high array voltage, the efficiency is high. A maximum power point tracker is used for optimal utilization of the photovoltaic array, which results in a high yield of the system. The power electronic converter is based on the topology of a Pulse Width Modulated Current Source Inverter (PWM-CSI). The inverter is operated at a high switching frequency (kHZ), so that waveforms with a low distortion are generated, while the power factor is near unity. Two modulations are described, both based on sinusoidal and preliminary test results are shown. ESA

N93-27613# Pacific Northwest Lab., Richland, WA.
EFFECTS OF COMPOSITION ON SINTERING OF CURRENT INTERCONNECTS IN SOFC
L. A. Chick and J. L. Bates Nov. 1992 5 p Presented at the Fuel Cell Seminar, Tucson, AZ, 29 Nov. - 2 Dec. 1992
(Contract DE-AC06-76RL-01830)
(DE93-004837; PNL-SA-21446; CONF-921114-4) Avail: CASI HC A01/MF A01

The sintering behavior of alkaline-earth-substituted lanthanum and yttrium chromites, which are candidates for the current interconnect in solid oxide fuel cells (SOFC) was investigated. Extensive commercialization of SOFC technology may involve co-sintering as a method to reduce production costs. Co-sintering will require that the interconnect material reaches high density (closed porosity) under conditions in which the air-electrode material, a manganite, maintains substantial porosity and remains stable. Therefore, ideal chromite compositions are those that attain greater than 94% of theoretical density in high P(O2) atmosphere at temperatures near or below 1400 C. DOE

N93-27626# Midwest Research Inst., Golden, CO. National Renewable Energy Lab.
INNOVATIVE SPUTTERING TECHNIQUES FOR CIS AND CdTe SUBMODULE FABRICATION
J. M. Armstrong, M. S. Misra, and B. Lanning Mar. 1993 62 p Prepared in cooperation with Martin Marietta Aerospace, Denver, CO
(Contract DE-AC02-83CH-10093)
(DE93-000085; NREL/TP-413-5406) Avail: CASI HC A04/MF A01

This report describes work done during Phase 1 of the subject subcontract. The subcontract was designed to study innovative deposition techniques, such as the rotating cylindrical magnetron sputtering system and electrodeposition for large-area, low-cost copper indium diselenide (CIS) and cadmium telluride (CdTe) devices. A key issue for photovoltaics (PV) in terrestrial and future space applications is producibility, particularly for applications using a large quantity of PV. Among the concerns for fabrication of polycrystalline thin-film PV, such as CIS and CdTe, are production volume, cost, and minimization of waste. Both rotating cylindrical magnetron (C-Mag(trademark)) sputtering and electrodeposition have tremendous potential for the fabrication of polycrystalline thin-film PV due to scaleability, efficient utilization of source materials, and inherently higher deposition rates. In the case of sputtering, the unique geometry of the C-Mag facilitates innovative cosputtering and reactive sputtering that could lead to greater throughput reduced health and safety risks, and, ultimately, lower fabrication cost. Electrodeposited films appear to be adherent and comparable with low-cost fabrication techniques. Phase 1 involved the initial film and device fabrication using the two techniques mentioned herein. Devices were tested by both internal facilities, as well as NREL and ISET. DOE

N93-28056# Midwest Research Inst., Golden, CO.
GALLIUM ARSENIDE-BASED TERNARY COMPOUNDS AND MULTI-BAND-GAP SOLAR CELL RESEARCH
S. Vernon (Spire Corp., Bedford, MA.) Feb. 1993 168 p
(Contract DE-AC02-83CH-10093)
(DE93-000084; NREL/TP-451-5333) Avail: CASI HC A08/MF A02

The aim of this contract is the achievement of a high-efficiency, low-cost solar cell. The basic approach to the problem is centered upon the heteroepitaxial growth of a 3-5 compound material onto a single-crystal silicon wafer. The growth technique employed is metalorganic chemical vapor deposition. The silicon wafer may serve as a mechanical substrate and ohmic contact for a single-junction device, or may contain a p-n junction of its own and form the bottom cell of a two junction tandem solar cell structure. The 3-5 material for the single-junction case is GaAs and for the two-junction case is either GaAlAs or GaAsP, either material having the proper composition to yield a band gap of approximately 1.7 eV. Results achieved in this contract include the following: (1) a 17.6% efficient GaAs-on-Si solar cell; (2) an 18.5% efficient GaAs-on-Si concentrator solar cell at 400 suns; (3) a 24.8% efficient GaAs-on-GaAs solar cell; (4) a 28.7% efficient GaAs-on-GaAs concentrator solar cell at 200 suns; (5) measurement of the effects of dislocation density and emitter doping on GaAs cells; and (6) improvements in the growth process to achieve reproducible thin AlGaAs window layers with low recombination velocities and environmental stability. DOE

N93-28060# Sandia National Labs., Albuquerque, NM.
OPERATION OF A SOLAR PHOTOCATALYTIC WATER TREATMENT SYSTEM AT A SUPERFUND SITE
J. E. Pacheco, M. Mehos (Midwest Research Inst., Golden, CO.), C. Turchi (Midwest Research Inst., Golden, CO.), and H. Link (Midwest Research Inst., Golden, CO.) 1992 10 p Presented at the 1st International Conference on TiO2 Photocatalytic Purification and Treatment of Air and Water, Ontario, 8-13 Nov. 1992
(Contract DE-AC04-76DP-00789)
(DE93-005354; SAND-92-2687C; CONF-9211168-1) Avail: CASI HC A02/MF A01

A solar photocatalytic process has been under development at both Sandia National Laboratories and the National Renewable Energy Laboratory (formerly the Solar Energy Research Institute). This process uses solar ultraviolet light to activate a titanium dioxide catalyst which oxidizes organic contaminants in water. In the summer of 1991, a solar photocatalytic detoxification of water system was installed and tested at a California Superfund Site located at Lawrence Livermore National Laboratory. The site was designated a Superfund Site because of widespread groundwater contamination which resulted from the release of chlorinated solvents, principally trichloroethylene, when the site was a Naval Air Station in the early 1940s. The objectives of these experiments were to measure the effects of process variables and the process efficiency in an actual remediation setting, to collect experimental data and operating experience in photocatalytic oxidation of organic contaminants, to develop accurate models of the system operation, and to develop control strategies. DOE

N93-28302# Office of Science and Technology, Washington, DC. Office of Program Analysis.
SUMMARY RESULTS OF AN ASSESSMENT OF RESEARCH PROJECTS

IN THE SOLAR FEDERAL WIND ENERGY RESEARCH PROGRAM
Dec. 1992 9 p
(DE93-005743; DOE/ST-0006P) Avail: CASI HC A02/MF A01

The Office of Program Analysis (OPA) undertook an assessment of 26 research projects (listed in Appendix A) sponsored by the Solar Thermal Electric Program. This report summarizes the results of that review. DOE

N93-28370# Department of Energy, Washington, DC. Office of Coal, Nuclear, Electric and Alternate Fuels.
RENEWABLE RESOURCES IN THE US ELECTRICITY SUPPLY
Mar. 1993 70 p
(DE93-009492; DOE/EIA-0561) Avail: CASI HC A04/MF A01

Renewable resources (solar, wind, geothermal, hydroelectric, biomass, and waste) currently provide nearly 12 percent of the Nation's electricity supply. Almost 10 of this 12 percent is provided by hydroelectric resources alone. Biomass and municipal solid waste (MSW) together contribute more than 1 percent. All other renewable resources, including geothermal, wind, and solar, together provide less than 1 percent of the total. Many renewable resources are relative newcomers to the electric power market. In particular, electricity generation using geothermal, wind, solar, and MSW resources have had their greatest expansion in the 1980's. This was a result of significant technological improvements, the implementation of favorable Federal and State policies, and the reaction to the increasing costs of using fossil and nuclear fuels. The use of renewable resources for electricity generation has also been encouraged as less environmentally damaging than fossil fuels. Because renewable energy is available domestically, renewable resources are viewed as more secure than imported fossil fuels. Descriptions of the history, current use, and forecasted future applications of renewable resources for electricity generation and of the factors that influence those applications are presented. DOE

N93-28406*# Arkansas Univ., Fayetteville. Dept. of Electrical Engineering.
STUDY OF THE STAEBLER-WRONSKI DEGRADATION EFFECT IN a-Si:H BASED P-I-N SOLAR CELL
H. A. Naseem, W. D. Brown, and S. S. Ang May 1993 23 p
(Grant NAG3-920)
(NASA-CR-193076; NAS 1.26:193076) Avail: CASI HC A03/MF A01

Conversion of solar energy into electricity using environmentally safe and clean photovoltaic methods to supplement the ever increasing energy needs has been a cherished goal of many scientists and engineers around the world. Photovoltaic solar cells on the other hand, have been the power source for satellites ever since their introduction in the early sixties. For widespread terrestrial applications, however, the cost of photovoltaic systems must be reduced considerably. Much progress has been made in the recent past towards developing economically viable terrestrial systems, and the future looks highly promising. Thin film solar cells offer cost reductions mainly from their low processing cost, low material cost, and choice of low cost substrates. These are also very attractive for space applications because of their high power densities (power produced per kilogram of solar cell pay load) and high radiation resistance. Amorphous silicon based solar cells are amongst the top candidates for economically viable terrestrial and space based power generation. Despite very low federal funding during the eighties, amorphous silicon solar cell efficiencies have continually been improved - from a low 3 percent to over 13 percent now. Further improvements have been made by the use of multi-junction tandem solar cells. Efficiencies close to 15 percent have been achieved in several labs. In order to be competitive with fossil fuel generated electricity, it is believed that module efficiency of 15 percent or cell efficiency of 20 percent is required. Thus, further improvements in cell performance is imperative. One major problem that was discovered almost 15 years ago in amorphous silicon devices is the well known Staebler-Wronski Effect. Efficiency of amorphous silicon solar cells was found to degrade upon exposure to sunlight. Until now their is no consensus among the scientists on the mechanism for this degradation. Efficiency may degrade anywhere from 10 percent to almost 50 percent within the first few months of operation. In order to improve solar cell efficiencies, it is clear that the cause or causes of such degradation must be found and the processing conditions altered to minimize the loss in efficiency. This project was initiated in 1987 to investigate a possible link between metallic impurities, in particular, Ag, and this degradation. Such a link was established by one of the NASA scientists for the light induced degradation of n+/p crystalline silicon solar cells. Author (revised)

N93-28435# New Energy and Industrial Technology Development Organization, Tokyo (Japan).
TREND SURVEY OF THE GLOBAL ENVIRONMENT ADAPTATION TYPE INDUSTRY TECHNOLOGY
Mar. 1992 170 p
(DE93-781442; NEDO-ITE-9110-2) Avail: CASI HC A08/MF A02

A global CO2 recycling system which combines utilization of natural energy and CO2 recovered from combustion of fossil fuel is studied. In the model, CO2 recovered at the place of energy demand is transported to the place where energy is produced, and from the CO2 fuels are synthesized by use of solar energy and transported to the place of energy demand. Facilities worth a large amount of money are required to transmit electric power generated by the photovoltaic power generation in the desert to the fuel synthesizing plant. Therefore, production of electrolytic hydrogen by the on-site power generation and transport by pipe may be considered. As a synthetic fuel being sent back by ocean transport, methanol is considered, and synthetic methane (LNG) can also be a candidate. CO2 is recovered as liquid carbon dioxide. Possibility of CO2 recycling is dependent on development of the desert solar base, as well as depletion of fossil fuel and price increase, CO2 penalty. It has still been difficult to say which of the fuel synthesis, CO2 tanker or securing of the solar base becomes a bottleneck. Entry of recycling fuels to the market will be possible in proportion to restrictions on fossil fuels, and evaluation of the system depends almost on the rate of energy arriving from the energy-producing region. DOE

N93-26688*# Arizona Univ., Tucson. Dept. of Materials Science and Engineering.
LAREG AREA SOLAR CELLS FROM LUNAR MATERIALS
Read Bryant, Paul Calvert, and Jean Corley *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 7 p (For primary document see N93-26674 10-91)
Avail: CASI HC A02/MF A03; 1 functional color page

N93-27806*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ADVANCED SOLAR DYNAMIC TECHNOLOGY PROGRAM
James Calogeras *In* NASA, Washington, Technology for Space Station Evolution. Volume 4: Power Systems/Propulsion/Robotics 1990 p 83-115 (For primary document see N93-27803 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

N93-27808*# TRW Defense and Space Systems Group, Redondo Beach, CA.
MINIATURIZED CASSEGRAINIAN SOLAR ARRAY DEVELOPMENT
R. Patterson and M. Mills *In* NASA, Washington, Technology for Space Station Evolution. Volume 4: Power Systems/Propulsion/Robotics 1990 p 123-128 Sponsored by NASA. Marshall Space Flight Center (For primary document see N93-27803 10-18)
Avail: CASI HC A02/MF A04; 1 functional color page

N93-27813*# Hamilton Standard, Windsor Locks, CT.
SPE (TM) REGENERATIVE HYDROGEN/OXYGEN FUEL CELLS FOR EXTRATERRESTRIAL SURFACE AND MICROGRAVITY APPLICATIONS
J. F. McElroy *In* NASA, Washington, Technology for Space Station Evolution. Volume 4: Power Systems/Propulsion/Robotics 1990 p 213-239 (For primary document see N93-27803 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

N93-27815*# International Fuel Cells Corp., South Windsor, CT.
FUEL CELL ENERGY STORAGE FOR SPACE STATION ENHANCEMENT
J. K. Stedman *In* NASA, Washington, Technology for Space Station Evolution. Volume 4: Power Systems/Propulsion/Robotics 1990 p 275-290 (For primary document see N93-27803 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

N93-27962*# Boeing Electronics High Technology Center, Seattle, WA.
ADVANCED PHOTOVOLTAIC POWER SYSTEMS USING TANDEM GaAs/GaSb CONCENTRATOR MODULES

L. M. Fraas, M. S. Kuryla, D. A. Pietila, V. S. Sundaram, P. E. Gruenbaum, J. E. Avery, V. Dihn, R. Ballantyne, and C. Samuel *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 13 p (For primary document see N93-27956 10-91)
Avail: CASI HC A03/MF A03

N93-27965*# International Fuel Cells Corp., South Windsor, CT.
FUEL CELL TECHNOLOGY FOR LUNAR SURFACE OPERATIONS
Henry J. DeRonck *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 4 p (For primary document see N93-27956 10-91)
Avail: CASI HC A01/MF A03

N93-27984*# Boeing Defense and Space Group, Huntsville, AL.
REGOLITH THERMAL ENERGY STORAGE FOR LUNAR NIGHTTIME POWER
Brian Tillotson *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 8 p Previously announced in IAA as A91-52340 (For primary document see N93-27956 10-91)
Avail: CASI HC A02/MF A03

45 ENVIRONMENT POLLUTION

Includes atmospheric, noise, thermal, and water pollution.

N93-26605# IT Environmental Programs, Inc., Cincinnati, OH.
ONSITE ENGINEERING REPORT FOR SOLIDIFICATION/STABILIZATION TREATMENT TESTING OF CONTAMINATED SOILS
J. Hessling, M. L. Smith, S. Giti-Pour, J. Miller, and J. Isenburg Mar. 1993 110 p
(Contract EPA-68-C9-0036)
(PB93-166965; EPA/600/R-93/051) Avail: CASI HC A06/MF A02

A pilot-scale test of the S/S technology was conducted. Three different binders (portland cement, a cement kiln dust and fly ash mixture, and a quicklime and fly ash mixture) were used in three binder-to-soil ratios each to determine the optimum mixtures for stabilizing lead in soil. The following binders were able to reduce the leachable lead content of the soil to less than 5 mg/L: 45 percent portland cement, 139.5 percent kiln dust and fly ash; 77.5 percent quicklime and fly ash; and 20 percent portland cement on soil that was heated prior to treatment to remove organic carbon from the soil. The report presents detailed information concerning the operation, sampling, and analysis for the solidification/stabilization treatment process. NTIS

N93-26607# Environmental Protection Agency, Research Triangle Park, NC.
MODELED MESOSCALE METEOROLOGICAL FIELDS WITH FOUR-DIMENSIONAL DATA ASSIMILATION IN REGIONAL SCALE AIR QUALITY MODELS
J. K. S. Ching and J. S. Irwin Jan. 1993 14 p See also PB87-190633 and PB92-213248 Prepared in cooperation with National Oceanic and Atmospheric Administration, Research Triangle Park, NC
(PB93-167229; EPA/600/A-93/046) Avail: CASI HC A03/MF A01

The paper addresses the need to increase the temporal and spatial resolution of meteorological data currently used in air quality simulation models (AQSM's). Transport and diffusion parameters, including mixing heights and stability, used in regulatory air quality dispersion models are currently computed using routinely collected twice daily (00Z and 12Z) upper air sounding data from approximately 100 locations and hourly surface data from approximately 300 locations spread across the U.S. The limited resolution data base limits the accuracy, reliability, and validity of the derived dispersion parameters for air quality models. The MM4-FDDA (Mesoscale Meteorological model, Version 4 with Four Dimensional Data Assimilation), a state-of-science dynamic modeling system that assimilates routinely available surface and upper air sounding data has been demonstrated to provide accurate and well characterized primary meteorological fields on hourly time intervals, with fine horizontal and vertical resolution. The MM4-FDDA can also provide as outputs, parameters such as surface heat and momentum fluxes which are necessary for computing the stability dispersion parameters. The goal of the study is to generate meteorological data with accuracy of transport, precipitation, and dynamic consistency superior to both direct interpolation of synoptic scale analysis of observations and on-site meteorology and purely predictive-mode model results. This is a demonstration project to produce a one year meteorological data base on an hourly basis for a horizontal grid resolution of 80 km and for 15 vertical layers is underway. NTIS

N93-26608# Environmental Protection Agency, Washington, DC. Office of Assistant Administrator for Water.
DEVELOPMENT DOCUMENT FOR EFFLUENT LIMITATIONS GUIDELINES AND NEW SOURCE PERFORMANCE STANDARDS FOR THE OFFSHORE SUBCATEGORY OF THE OIL AND GAS EXTRACTION POINT SOURCE CATEGORY Final Report
15 Jan. 1993 386 p See also PB86-114949
(PB93-167310; EPA/821/R-93/003) Avail: CASI HC A17/MF A04

The rule establishes regulations based on Best Available Technology (BAT) that will result in reasonable progress toward the goal of the Clean Water Act (CWA) to eliminate the discharge of all pollutants. At a minimum, BAT represents the best economically achievable performance in the industrial category or subcategory. The rule also establishes requirements based on Best Conventional Technology (BCT). In addition, the rule establishes New Source Performance Standards (NSPS) based on the best demonstrated control technology. NTIS

N93-26621# Viar and Co., Alexandria, VA. Environmental Services Div.
METHODS FOR THE DETERMINATION OF DIESEL, MINERAL, AND CRUDE OILS IN OFFSHORE OIL AND GAS INDUSTRY DISCHARGES
Dec. 1992 80 p See also PB-277 256, PB-297 451 and PB86-114949 Sponsored by Environmental Protection Agency, Washington LIMITED REPRODUCIBILITY: More than 20% of this document may be affected by microfiche quality
(Contract EPA-68-C9-0019)
(PB93-166932; EPA/821/R-92/008) Avail: CASI HC A05

The document is a compendium of analytical methods which support Subpart A of 40 CFR Part 435, effluent limitations guidelines for the Offshore subcategory of the Oil and Gas Extraction Point-Source Category. Methods 1651, 1654, 1662, and 1663 are discussed. NTIS

N93-26622# Environmental Protection Agency, Research Triangle Park, NC. Atmospheric Research and Exposure Assessment Lab.
EMISSIONS AND FUEL ECONOMY OF FEDERAL ALTERNATIVELY FUELED FLEET VEHICLES
P. Gabele and F. Black Feb. 1993 17 p LIMITED REPRODUCIBILITY: More than 20% of the document may be affected by microfiche quality
(PB93-167195; EPA/600/A-93/043) Avail: CASI HC A03

The paper presents results from a study designed to investigate the effects of automobile fuels on emissions and fuel economy. The study is part of a larger program mandated by the Alternative Motor Fuels Act of 1988 that requires the Department of Energy (DOE), in cooperation with the Environmental Protection Agency (EPA), to examine the effects of using various alternative fuels in motor vehicles. A total of ten fuels and six vehicles has been tested to date, and additional tests are being planned as the project continues. NTIS

N93-26623# Eastern Research Group, Inc., Lexington, MA.
COST-EFFECTIVENESS ANALYSIS OF FINAL EFFLUENT LIMITATIONS GUIDELINES AND STANDARDS OF PERFORMANCE FOR THE OFFSHORE OIL AND GAS INDUSTRY
Jan. 1993 63 p See also PB93-153989 and PB93-167310 Sponsored by EPA
(PB93-169118; EPA/821/R-93/005) Avail: CASI HC A04/MF A01

The EPA proposed effluent limitations guidelines and standards for the offshore segment of the oil and gas industry on August 26, 1985. On November 26, 1990, and March 13, 1991, the Agency reproposed effluent limitations guidelines and standards for both drilling and production wastes. The report is primarily concerned with the total annualized cost incurred by the offshore oil and gas industry in complying with the regulations. NTIS

N93-26632# Environmental Protection Agency, Washington, DC. Office of Modeling, Monitoring Systems, and Quality Assurance.
EMAP MONITOR: FEBRUARY 1993 EDITION

T. L. Baugh and M. McNamara Feb. 1993 13 p See also PB92-239557 LIMITED REPRODUCIBILITY: More than 20% of this document may be affected by microfiche quality
(PB93-163020; EPA/620/N-92/001) Avail: Issuing Activity (National Technical Information Service (NTIS))

EMAP is a complex and diverse program that requires efficient communications to ensure continuity and consistency in the program and to avoid duplication. The monitor is a regularly published document intended to provide an efficient and effective tool for EMAP managers to communicate the status and progress of the program to EPA and the scientific community and to transfer technical information to a broad audience. The edition contains a feature article on the Forest Health Monitoring Program. It also contains a summary of the current activities of selected EMAP components, a listing of upcoming major publications. NTIS

N93-27012*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

NITRIC OXIDE FORMATION IN A LEAN, PREMIXED-PREVAPORIZED JET A/AIR FLAME TUBE: AN EXPERIMENTAL AND ANALYTICAL STUDY

Chi-Ming Lee, Jean Bianco (Ohio Aerospace Inst., Brook Park.), John M. Deur (Sverdrup Technology, Inc., Brook Park, OH.), and Bahman Ghorashi (Cleveland State Univ., OH.) Nov. 1992 15 p
(RTOP 537-01-11)
(NASA-TM-105722; E-7121; NAS 1.15:105722) Avail: CASI HC A03/MF A01

An experimental and analytical study was performed on a lean, premixed-prevaporized Jet A/air flame tube. The NO(x) emissions were measured in a flame tube apparatus at inlet temperatures ranging from 755 to 866 K (900 to 1100 F), pressures from 10 to 15 atm, and equivalence ratios from 0.37 to 0.62. The data were then used in regressing an equation to predict the NO(x) production levels in combustors of similar design. Through an evaluation of parameters it was found that NO(x) is dependent on adiabatic flame temperature and combustion residence time, yet independent of pressure and inlet air temperature for the range of conditions studied. This equation was then applied to experimental data that were obtained from the literature, and a good correlation was achieved. Author

N93-27055# Agricultural Research Service, Beltsville, MD.

OPUS: AN INTEGRATED SIMULATION MODEL FOR TRANSPORT OF NONPOINT-SOURCE POLLUTANTS AT THE FIELD SCALE. VOLUME 2: USER MANUAL

Virginia A. Ferreira and Roger E. Smith Dec. 1992 204 p
(PB93-161628; ARS-98-Vol-2) Avail: CASI HC A10/MF A03

The Opus model simulates interaction of water movement with the application, transformation, and movement of nonpoint-source pollutants in an agricultural field. The modeled processes include hydrology, erosion, weather, crop growth, agricultural management, nutrient cycling and transport, and pesticide fate. The field size is limited to catchments with a single raingage record and a single soil profile. Time scales vary by process and conditions: from fractions of a second in some hydrologic components to years in annual management cycles. Many processes proceed on a daily time step. The document describes the use of the computer program. Input variables and parameters are described, and relationships among some are explained. NTIS

N93-27163*# North Carolina State Univ., Raleigh. Dept. of Chemical Engineering.

HETEROGENEOUS PHOTOCATALYTIC OXIDATION OF ATMOSPHERIC TRACE CONTAMINANTS Semiannual Progress Report No. 4, 1 May - 31)ct. 1992

David F. Ollis 2 Apr. 1993 34 p
(Grant NAG2-684)
(NASA-CR-192988; NAS 1.26:192988) Avail: CASI HC A03/MF A01

Work performed during the period 1 May - 31 Oct. 1992 on heterogeneous photocatalytic oxidation of atmospheric trace contaminants is presented. Topics discussed include photoreactor monolith fundamental studies and monolith reactor operation: batch recirculation system. CASI

N93-27401# MBC Applied Environmental Sciences, Inc., Costa Mesa, CA.

SEVENTH ANNUAL INFORMATION TRANSFER MEETING. OUR CHANGING COASTAL ENVIRONMENT: RESEARCH ON NATURAL PROCESSES AND MAN'S INFLUENCE

Sep. 1992 275 p Conference held in Ventura, CA, 12-15 May 1992 See also PB91-123992 Sponsored by Minerals Management Service, Camarillo, CA LIMITED REPRODUCIBILITY: More than 20% of this document may be affected by microfiche quality
(Contract DI-14-35-0001-30525)
(PB93-173813; OCS/MMS-92/0048) Avail: Issuing Activity (National Technical Information Service (NTIS))

The report documents the proceedings of the Seventh Information Transfer Meeting (ITM) held May 12-15, 1992 in Ventura, CA. The ITM was sponsored by the U.S. Department of Interior, Minerals Management Service (MMS) and was attended by over 200 persons. The theme was Our Changing Coastal Environment: Research on Natural Processes and Man's Influence. Day one included a geology field trip to Carpinteria guided by MMS geology experts, presentations by MMS staff on MMS research and special projects, and an evening exhibit session. Day two topics explored how scientific information is developed and used. Day three included presentations on Current Research on Natural Processes, Research on Man's Influence on the Coastal Environment and Positive Responses to Man-Induced Impacts. Day four was devoted to a database demonstration session. Talks were given by the U.S. Department of the Interior, industry, environmental groups, government and county representatives, and academia. NTIS

N93-27402 National Academy of Sciences - National Research Council, Washington, DC. Board on Agriculture.

SUSTAINABLE AGRICULTURE AND THE ENVIRONMENT IN THE HUMID TROPICS

1993 718 p Sponsored by Agency for International Development, Washington, DC. Office of Agriculture LIMITED REPRODUCIBILITY: More than 20% of this document may be affected by microfiche quality
(PB93-173920; ISBN-0-309-04749-8) Copyright Avail: Issuing Activity (National Technical Information Service (NTIS))

The book provides strategies for sustainable land use that can halt needless deforestation, further degradation of land, and the irreversible loss of biological resources. A 15-member committee of international experts presents a practical discussion of 12 major land use options that regional and national leaders can use in making decisions to boost food production and local income while protecting the natural resource base. Recommendations are offered for developing the technologies needed for sustainable agriculture and recovery of degraded lands, and a strategy is presented for changing current policies and incentives that often encourage environmentally destructive land use practices. An appendix addresses emissions of greenhouse gases from tropical deforestation and land use. The report also profiles seven humid tropical countries and points to examples of successful land restoration. NTIS

N93-27404# Maryland Dept. of Natural Resources, Annapolis. Maryland Power Plant and Environmental Review Div.

BIBLIOGRAPHY OF THE MARYLAND POWER PLANT RESEARCH PROGRAM, FOURTEENTH EDITION

R. I. McLean Feb. 1993 98 p See also PB92-161124
(PB93-174241; PPRP-B-14) Avail: CASI HC A05/MF A02

The Power Plant Siting Act of 1971 (Sec. 3-303) established the Power Plant Research Program to ensure that demands for electric power would be met in a timely manner at a reasonable cost while assuring that the associated environmental impact would be acceptable. The scope of the Program extends to estimating the impact of proposed new generating facilities, evaluating the acceptability of proposed transmission line routes, assessing the impact of existing generation facilities, and investigating generic issues related to power plant site evaluation and associated environmental and land use considerations. The bibliography is a compilation of all the studies performed for and/or by the Power Plant and Environmental Review Division since its inception. NTIS

N93-27406# RCG/Hagler, Bailly, Inc., Boulder, CO.
REGULATORY IMPACT ANALYSIS OF FINAL EFFLUENT LIMITATIONS GUIDELINES AND STANDARDS FOR THE OFFSHORE OIL AND GAS INDUSTRY Final Report
14 Jan. 1993 110 p See also PB93-167310 and PB93-173939
(Contract EPA-68-C8-0084)
(PB93-174613; EPA/821/R-93/002) Avail: CASI HC A06/MF A02

For all major rulemaking actions, Executive Order 12291 requires a Regulatory Impact Analysis (RIA), in which benefits of the regulation are compared to costs imposed by the regulation. The report presents the Environmental Protection Agency's (EPA, or the Agency) RIA of the final rule on the effluent limitations guidelines for the Offshore Subcategory of the Oil and Gas Extraction Industry. The principal requirement of the Executive Order is that the Agency perform an analysis comparing the benefits of the regulation to the costs that the regulation imposes. Three types of benefits are analyzed in this RIA: quantified and monetized benefits; quantified and non-monetized benefits; and non-quantified and non-monetized benefits. NTIS

N93-27410# Forest Service, Asheville, NC. Southeastern Forest Experiment Station.
SOUTHERN GLOBAL CHANGE PROGRAM. DETERMINING THE RELATIONSHIPS BETWEEN AIR POLLUTANTS, CLIMATE CHANGE, AND SOUTHERN FORESTS Forest Service General Technical Report
29 Mar. 1993 30 p
(PB93-176246; FSGTR-SE-79) Avail: CASI HC A03/MF A01

The Southeastern and Southern Forest Experiment Stations of the United States Department of Agriculture (USDA) Forest Service chartered a joint research initiative in 1990 called the Southern Global Change Program (SGCP). The SGCP was developed to improve our understanding of the interactions among southern forests, air pollution, and climate change. The SGCP will address questions about the ecological and socioeconomic impacts of global change on the South, as well as questions about how management practices and policies should be modified in order to adapt to or mitigate these effects. The SGCP will provide information necessary to meet the challenge of maintaining forest health, productivity, and diversity in the face of global environmental change. This document describes the activities of the SGCP and identifies its relationship to the U.S. Global Change Research Program. NTIS

N93-27423# Illinois Univ., Urbana. Inst. of Environmental Studies.
ORGANIC PHOSPHORUS COMPOUNDS IN THE HYDROSPHERE: CHARACTERISTICS, IDENTITY, AND DYNAMICS Final Report
R. A. Minear 31 Dec. 1992 140 p
(Contract USGS-14-08-0001-G1659)
(PB93-173011) Avail: CASI HC A07/MF A02

Identification and characterization of dissolved organic phosphorus (DOP) present in the waters of Crystal Lake in Urbana, IL, and Walker Branch at Oak Ridge, TN using ultrafiltration (UF) and reverse osmosis (RO) concentration methods, high performance liquid chromatography (HPLC), and Phosphorus-31 Fourier Transform Nuclear Magnetic Resonance spectroscopy (31P FT-NMR) is reported. UF and RO membrane methods enabled a several thousand fold concentration of the DOP, which was necessary for detection by HPLC and 31P FT-NMR. The behavior and recovery of aquatic DOP compounds with several UF and RO membranes were examined and a membrane configuration consisting of a 30 K dalton UF membrane, a 1 K dalton UF membrane, and a RO 95 percent NaCl rejection membrane, in series, was used to concentrate and fractionate DOP according to its molecular size. Extensive concentration with UF and RO membrane methods appear to produce aggregation of dissolved organic carbon compounds with the concurrent adsorption or incorporation of DOP. NTIS

N93-27512# Eastern Research Group, Inc., Lexington, MA.
ECONOMIC IMPACT ANALYSIS OF FINAL EFFLUENT LIMITATIONS GUIDELINES AND STANDARDS OF PERFORMANCE FOR THE OFFSHORE OIL AND GAS INDUSTRY
M. F. Kaplan and E. M. Sigler Jan. 1993 520 p See also PB93-167039 Sponsored by Environmental Protection Agency Economic and Statistical Analysis Branch, Washington, DC LIMITED REPRODUCIBILITY: More than 20% of this document may be affected by microfiche quality
(PB93-173979; EPA/821/R-93/004) Avail: Issuing Activity (National Technical Information Service (NTIS))

The document is an economic impact analysis prepared in support of the promulgation of effluent limitations guidelines and standards of performance for drilling and production wastes for the offshore oil and gas industry. The report analyzes the economic impact of alternative regulatory options considered for drilling fluids, drill cuttings, produced water, produced sand, and treatment, workover, and completion fluids. NTIS

N93-27515# Forest Service, Radnor, PA. Northeastern Forest Experiment Station.
CHICAGO'S EVOLVING URBAN FOREST: INITIAL REPORT OF THE CHICAGO URBAN FOREST CLIMATE PROJECT, 1993 Forest Service General Final Technical Report
E. G. McPherson, D. J. Nowak, P. L. Sacamano, S. E. Prichard, and E. M. Makra Jan. 1993 59 p See also PB93-129815
(PB93-174050; FSGTR-NE-169) Avail: CASI HC A04/MF A01

The report traces the history of Chicago's landscape as it has evolved from a mixture of prairie, wetlands, and oak-hickory forests into a major metropolis. An analysis of 1987 aerial photographs indicates that Chicago-area tree cover has increased from a presettlement level of about 13 percent to nearly 20 percent today. Street trees predominate in Chicago's residential areas, where buildings and paving restrict tree cover in many off-street locations. Larger percentages of tree cover were found for off-street trees in suburban Cook and DuPage Counties. Chicago's urban climate is associated with increases in rainfall and flooding, summertime temperatures and air conditioning use, and unhealthy levels of ozone. The potential of urban vegetation to improve environmental quality is reviewed and the Chicago urban Forest Climate Project research plan is described. NTIS

N93-27519# ICF Consulting Associates, Inc., Universal City, CA.
STUDY OF EMISSIONS AND CONTROL OF STRATOSPHERIC OZONE-DEPLETING COMPOUNDS IN CALIFORNIA Final Report
Michael J. Gibbs, John Wasson, Thomas Magee, Peter Linquiti, and Sudhaker Kesavan Oct. 1992 305 p
(Contract ARB-AO32-131)
(PB93-160752; ARB-R-93/452) Avail: CASI HC A14/MF A03

The objective of this project is to compile data and analyses for the Air Resources Board (ARB) that will allow the Board and its staff to understand and assess the full range of issues regarding emissions of stratospheric ozone-depleting compounds (ODC's) and their control. The ODC's of interest in the study are the fully halogenated Chlorofluorocarbons (CFC's); the partially halogenated chlorofluorocarbons (HCFC's); the bromine-containing halon compounds; methyl chloroform; and carbon tetrachloride. These compounds are currently the focus of national and international control efforts. The report presents the following topics: (1) U.S. and California ODC emissions inventories for 1990 and 2005 that reflect current and expected future restrictions on ODC production, use, and emissions; (2) detailed descriptions of the technologies available for reducing ODC use and emissions; and (3) summaries of current federal, state, and local legislations affecting ODC use and emissions. NTIS

N93-27527# Environmental Protection Agency, Research Triangle Park, NC. Air and Energy Engineering Research Lab.
TECHNOLOGICAL OPTIONS FOR ACID RAIN CONTROL
F. T. Princiotta and C. B. Sedman 1993 27 p See also PB88-143995 and PB91-197202
(PB93-173094; EPA/600/A-93/061) Avail: CASI HC A03/MF A01

The paper discusses technological options for acid rain control. Compliance with Title IV of the Clean Air Act Amendments of 1990 will require careful scrutiny of a number of issues before selecting control options to reduce sulfur dioxide (SO2) and nitrogen oxide (NOx) emissions. One key consideration is the effect of fuel switching or control technology upon the existing dust collector, with additional air toxics legislation looming ahead. A number of likely SO2 and NOx retrofit technologies and estimated costs are presented, along with results of retrofit case studies. New hybrid particulate controls are also being developed to meet future requirements. NTIS

N93-27536*# Purdue Univ., West Lafayette, IN. Dept. of Earth and Atmospheric Sciences.

THE ROLE OF GLOBAL CLOUD CLIMATOLOGIES IN VALIDATING NUMERICAL MODELS Final Technical Report, 1 Apr. 1989 - 31 Mar. 1993

Harshvardhan 1993 228 p

(Grant NAG5-1125)

(NASA-CR-193135; NAS 1.26:193135) Avail: CASI HC A11/MF A03

The purpose of this work is to estimate sampling errors of area-time averaged rain rate due to temporal samplings by satellites. In particular, the sampling errors of the proposed low inclination orbit satellite of the Tropical Rainfall Measuring Mission (TRMM) (35 deg inclination and 350 km altitude), one of the sun synchronous polar orbiting satellites of NOAA series (98.89 deg inclination and 833 km altitude), and two simultaneous sun synchronous polar orbiting satellites--assumed to carry a perfect passive microwave sensor for direct rainfall measurements--will be estimated. This estimate is done by performing a study of the satellite orbits and the autocovariance function of the area-averaged rain rate time series. A model based on an exponential fit of the autocovariance function is used for actual calculations. Varying visiting intervals and total coverage of averaging area on each visit by the satellites are taken into account in the model. The data are generated by a General Circulation Model (GCM). The model has a diurnal cycle and parameterized convective processes. A special run of the GCM was made at NASA/GSFC in which the rainfall and precipitable water fields were retained globally for every hour of the run for the whole year. Author (revised)

N93-27617# Tennessee Univ., Tullahoma. Space Inst.

MHD CAN CLEAN UP THE ENVIRONMENT

A. C. Sheth, L. W. Crawford, and J. K. Holt 1993 12 p Presented at the 55th Annual American Power Conference, Chicago, IL, 13-15 Apr. 1993

(Contract DE-AC02-79ET-10815)

(DE93-008015; DOE/ET-10815/206; CONF-930433-1) Avail: CASI HC A03/MF A01

Magnetohydrodynamics (MHD) involves interactions among electromagnetic fields and electrically conducting gases and liquids. The most developed application for MHD in the United States is for central station electric power generation using a coal-fired combined cycle system. Proof-of-Concept (POC) scale demonstration of the downstream components used in this technology is currently being carried out at the U.S. Department of Energy's (DOE) Coal-Fired Flow Facility (CFFF), located at the University of Tennessee Space Institute (UTSI). Some of the attractive features of MHD include: A potential for increasing overall plant efficiency to 60% as compared to less than 40% for conventional power plants; provision of built-in controls to eliminate/reduce the emissions of acid rain precursors, such as SO2 and NO(x) well below the existing New Source Performance Standards (NSPS) and Clean Air Act requirements; provision of adequate particulate resistivity for easy and efficient capture of submicron sized particles in dry and wet electrostatic precipitators; provision of built-in control to eliminate/reduce the Cl2/HCl emission problems common to waste incinerators; producing nearly zero emissions of priority pollutants (inorganics as well as organics on a pound per pound of coal basis) in comparison to conventional coal-fired facilities; environmentally acceptable solid and liquid waste streams, and release of less CO2 (a suspected greenhouse gas) per unit of electricity generated than the conventional power plant due to the increased efficiency. DOE

N93-27649 Royal Netherlands Meteorological Inst., De Bilt. Physical Meteorology Dept.

TURBULENT EXCHANGE COEFFICIENTS OVER A DOUGLAS FIR FOREST

F. C. Bosveld 1991 45 p

(KNMI-WR-91-02; ISBN-9-03-692006-X; ETN-93-93586) Copyright Avail: Royal Netherlands Meteorological Inst., Postbus 201, 3730 AE De Bilt, Wilhelminalaan 10, Netherlands

Experiments performed as part of a project to determine the turbulent exchange coefficients over a Douglas fir forest in the Speulderbos region (Holland) are described. Emphasis is on the formulation of the results in a form suitable for the derivation of fluxes of air pollution components from profile measurements. An outline of surface layer similarity theory is given together with the main limitations for its use over a forest. The instruments and their accuracy in relation to the desired accuracy for obtaining reliable flux gradient relations are described. The measurements are presented together with an analysis of the main factors that influence the turbulent exchange over the forest. A simple extension of the usual flux gradient relations is proposed to incorporate the main observed features. A simple recipe for calculating fluxes from profile measurements is given. Auxiliary measurements made on a second mast in the forest are analyzed to get an impression of the homogeneity of the flux and gradient fields over the forest stand. Two appendices are included. One on the influence of finite averaging time in the derived flux gradient relations and one on the sensitivity of the results in the choice of the displacement height. ESA

N93-28057# Lawrence Livermore National Lab., CA.

TERRESTRIAL BIOGEOCHEMICAL CYCLING AND VEGETATION RESPONSE TO CLIMATE IN AN EARTH SYSTEM MODEL

J. R. Kercher, M. C. Axelrod, M. C. MacCracken, and J. Q. Chambers (California Univ., Santa Barbara.) Oct. 1992 17 p Presented at the 3rd International Workshop on Closed Ecological Systems, Oracle, AZ, Apr. 1992

(Contract W-7405-eng-48)

(DE93-003464; UCRL-JC-112100; CONF-9204215-1) Avail: CASI HC A03/MF A01

We are developing (1) a seasonal model of terrestrial productivity and biogeochemical cycling (TERRA), and (2) a model of vegetation response to climate (HABITAT). Both of these models are designed to be components of an Earth System Model being developed at Lawrence Livermore National Laboratory (LLNL). We have implemented the grid-cell model of TERRA and have calibrated it for the 17 vegetation types that it simulates. In a sensitivity analysis, we have found that total system response is most sensitive to parameters affecting soil moisture content which, in turn, affects soil respiration. Albedo was found to be an important factor in tundra systems. Carbon sequestration was strongly influenced by only a handful of parameters for each of the five types discussed in this paper. Parameters affecting soil respiration, soil moisture, litterfall rate, CO2 assimilation, C:N ratio in litterfall, and nitrogen uptake were, in most circumstances, found to be the most important parameters. As an initial phase in constructing the vegetation response model, we have investigated an existing method of classifying vegetation life zones based on total annual precipitation and average monthly temperature to determine if this method discriminates between vegetation types. We used global vegetation and climatic data sets for this analysis. We found that these variables lack power to resolve vegetation types. DOE

N93-28300# Department of Energy, Albuquerque, NM. Operations Office.

KAUAI TEST FACILITY CDX ROCKET OPERATION ENVIRONMENTAL ASSESSMENT, SANDIA NATIONAL LABORATORIES, ALBUQUERQUE, NEW MEXICO

1992 48 p

(DE93-005491; DOE/EA-0786) Avail: CASI HC A03/MF A01

This report presents information on the need for action, alternative, description of the affected environment, and environmental impacts of the proposed action. DOE

N93-28419# Lawrence Livermore National Lab., CA.

DEVELOPMENT AND EVALUATION OF A CLEANABLE HIGH EFFICIENCY STEEL FILTER

W. Bergman, G. Larsen, F. Weber, P. Wilson, R. Lopez, G. Valha, J. Conner, J. Garr, K. Williams, and A. Biermann et al Jan. 1993 29 p Presented at the 22nd Department of Energy (DOE)/Nuclear Regulatory Commission (NRC) Nuclear Air Cleaning and Treatment Conference, Denver, CO, 24-27 Aug. 1992

(Contract W-7405-eng-48)

(DE93-008024; UCRL-JC-109769; CONF-920823-8) Avail: CASI HC A03/MF A01

A high efficiency steel filter that can be cleaned in-situ by reverse air pulses was developed. The filter consists of 64 pleated cylindrical filter elements packaged into a 610x610x292 mm aluminum frame and has 13.5 sq m of filter area. The filter media consists of a sintered steel fiber mat using 2 microns diameter fibers. An optimization study for filter efficiency and pressure drop was conducted to determine the filter design parameters of pleat width, pleat depth, outside diameter of the cylinder, and the total

number of cylinders. Several prototype cylinders were then built and evaluated in terms of filter cleaning by reverse air pulses. The results of these studies were used to build the high efficiency steel filter. The prototype filter was evaluated for efficiency and cleanability. The DOP filter certification test showed the filter has a passing efficiency of 99.99% but a failing pressure drop of 0.80 kPa at 1,700 cu m/hr. Since a pressure drop less than 0.25 kPa was not achieved the steel filter does not meet all the criteria for a HEPA filter. Filter loading and cleaning tests using AC Fine dust showed the filter could be repeatedly cleaned by reverse air pulses. The next phase of the prototype evaluation consisted of installing the unit and support housing in the exhaust duct work of a uranium grit blaster for a field evaluation at the Y-12 Plant in Oak Ridge, TN. The grit blaster is used to clean the surface of uranium parts and generates a cloud of UO2 aerosols. A 1,700 cu m/hr slip stream from the 10,200 cu m/hr exhaust system was used. DOE

N93-28434# New Energy and Industrial Technology Development Organization, Tokyo (Japan).
TREND SURVEY OF THE GLOBAL ENVIRONMENT ADAPTATION TYPE INDUSTRIAL TECHNOLOGY
Mar. 1992 161 p
(DE93-781441; NEDO-ITE-9110-1) Avail: CASI HC A08/MF A02

The measures for reduction of environmental load of CO2 from the standpoint of chemical technology is studied. As for methanol synthesis from CO2, accelerating of the reaction using Cu base compound catalyst is reported. Also, CO2 is methanated at high speed by low temperature waste heat using Ni-La2O3-Ru catalyst. Discussions are given on the subject for development of catalyst reaction relating to hydrogen production technology by methane reforming reaction using steam or CO2. Synthesis of polymetric materials by use of CO2 is also described. It is indispensable to design high-function electrode and elucidate the reaction mechanism of electrochemical CO2 reduction for electrochemical and photochemical CO2 reduction measures. Moreover, in case of using solar energy, it is required to study photovoltaic excitation process in semiconductor electrode/electrolyte solution interface. For production of hydrogen from CO2 by photosynthetic organisms and solar energy, the problem is control of inhibiting effect of oxygen combinedly produced. Described are production of polyhydroxy butyric acid and biodegradable polymer from CO2 and hydrogen by bacteria, and CO2 fixation imitating the enzyme reaction. DOE

N93-26997# Meteorological Satellite Center, Tokyo (Japan).
DERIVATION OF TOTAL OZONE AMOUNT FROM NOAA/TOVS DATA
Yoshito Yoshizaki *In its* Meteorological Satellite Center Technical Note, No. 25, 1992 Nov. 1992 p 89-105 In JAPANESE Original contains color illustrations (For primary document see N93-26991 10-47)
Avail: CASI HC A03/MF A02

46 GEOPHYSICS

Includes aeronomy; upper and lower atmosphere studies; ionospheric and magnetospheric physics; and geomagnetism.
For space radiation see *93 Space Radiation.*

N93-26609# National Oceanic and Atmospheric Administration, Boulder, CO. Environmental Research Labs.
NOAA AERONOMY LABORATORY QUADRENNIAL REPORT, 1989-1992: A SUMMARY OF THE PAST FOUR YEARS AND A LOOK AHEAD
Feb. 1993 94 p See also PB86-182912
(PB93-167401) Avail: CASI HC A05/MF A01

The NOAA Aeronomy Laboratory Quadrennial Report for 1989-1992 is presented. Atmospheric science issues of concern to the Laboratory are discussed. Research conducted by the Laboratory from 1989 to 1992 is described. Research efforts focused on ozone chemistry in the troposphere, the stratospheric ozone layer, and greenhouse gases and climatic change. NTIS

N93-26666# Westinghouse Savannah River Co., Aiken, SC.
MESOSCALE ATMOSPHERIC MODELING FOR EMERGENCY RESPONSE
B. L. OSteen and J. D. Fast 1992 20 p Presented at the Spring National Meeting of the AIChe, Houston, TX, 5-8 Apr. 1993
(Contract DE-AC09-89SR-18035)
(DE93-008509; WSRC-MS-92-520; CONF-930494-1) Avail: CASI HC A03/MF A01

Atmospheric transport models for emergency response have traditionally utilized meteorological fields interpolated from sparse data to predict contaminant transport. Often these fields are adjusted to satisfy constraints derived from the governing equations of geophysical fluid dynamics, e.g. mass continuity. Gaussian concentration distributions or stochastic models are then used to represent turbulent diffusion of a contaminant in the diagnosed meteorological fields. The popularity of these models derives from their relative simplicity, ability to make reasonable short-term predictions, and, most important, execution speed. The ability to generate a transport prediction for an accidental release from the Savannah River Site in a time frame which will allow protective action to be taken is essential in an emergency response operation. DOE

N93-26671# Stanford Univ., CA.
GEOTHERMAL RESEARCH AND DEVELOPMENT PROGRAM
25 Jan. 1993 36 p
(Contract DE-FG07-90ID-12934)
(DE93-008400; DOE/ID-12934/16) Avail: CASI HC A03/MF A01

Results are reported on adsorption of water vapor on reservoir rocks, physics of injection of water into vapor-dominated geothermal reservoirs, earth-tide effects on downhole pressures, injection optimization at the Geysers, effects of salinity in adsorption experiments, interpreting multiwell pressure data from Ohaaki, and estimation of adsorption parameters from transient experiments. DOE

N93-27059# National Oceanic and Atmospheric Administration, Washington, DC. National Environmental Satellite, Data, and Information Service.
ADJUSTMENT OF TIROS OPERATIONAL VERTICAL SOUNDER DATA TO A VERTICAL VIEW
David Q. Wark Mar. 1993 42 p
(NOAA-TR-NESDIS-64) Avail: CASI HC A03/MF A01

In an earlier study, observations from the Special Sensor, Meteorological/Temperature (SSM/T) on the Defense Meteorological Satellite Program satellites have been used to calculate limb adjustment coefficients to transform all SSM/T data to the values they would have in a vertical view. Application of the same methods to the TIROS Operational Vertical Sounder (TOVS) measurements in the infrared regions was hampered by the irregularities of clouds and their influence on radiance temperatures. To overcome this difficulty, the angular distributions of measurements for each spectral interval were smoothed by a simple quadratic expression. The much greater number of channels in the TOVS allows a broader range of eligible channels in the algorithm for angle adjustment, although each eligible channel must be related physically rather than only statistically. Selection of channels was performed by computing all possible combinations of channels with one, two, and three associated channels and applying two criteria: minimization of the RMS fit and minimization of noise amplification. Estimated errors of fit to the data are generally less than the electrical noise of the instruments. It is shown that the smoothed latitudinal means represent individual sets of observations over a broad range of meteorological conditions and therefore satisfy the angular and universality of requirements placed on the algorithm. Author

N93-27079# National Oceanic and Atmospheric Administration, Washington, DC. National Environmental Satellite, Data, and Information Service.
A NOISE LEVEL ANALYSIS OF SPECIAL MULTIPLE-SPIN VAS DATA DURING STORM-FEST
Donald W. Hillger, James F. W. Purdom, and Debra A. Molenar (Colorado State Univ., Fort Collins.) Apr. 1993 37 p
(Grant NA85RA-H-05045)
(NOAA-TR-NESDIS-65) Avail: CASI HC A03/MF A01

In December 1989, a special collection period for VAS (VISSR Atmospheric Sounder) data was arranged in order to test the effect of spin budget (multiple samples at the same field-of-view (FOV)) on the noise levels of the VAS channels. Results of that study were reported in NOAA Technical Report 56. However, upon completion of that study, we

decided to recalculate some of the results with improvements learned during the first study. Those improvements are: (1) to calculate the results in radiance units instead of effective black body temperature units; and (2) to save VAS data off the edges of the earth to better compare with the space-look noise levels provided by CIMSS. At the same time, some subtle errors in the analysis software were corrected, resulting in noise levels that now conform to the expected theoretical decrease with increasing numbers of spins. Special multiple-spin VAS data were available during STORM-FEST (STormscale Operational Research and Meteorology - Fronts Experiment Systems Test) to accomplish these technical improvements. Like the old study, this new study compares noise levels of the VAS channels determined by three methods to the design specifications for the VAS instrument. Results from the three analysis methods agree in general, and results conform to design specification as well, but with some differences. The agreements indicate that all three noise level estimating methods are viable, but the differences indicate that the three methods for determining noise levels should occasionally be intercompared using operational data sets. Finally, noise levels were calculated as a function of time of day, to determine if there was any systematic diurnal variation that can be determined. Results indicate that there was no detectable diurnal variation in noise level of any of the VAS channels. Noise levels should be determined frequently for any operational data set. For VAS the requirements for sounding errors can then be used to specify the spin budget (number of temporal samples) or the spatial averaging needed to meet those requirements. In the case of GOES-Next, the FOV dwell time may be increased or decreased to alter noise levels. The change in noise level with dwell time should be an ongoing test applied to operational data from GOES-Next. Author

N93-27144*# California Univ., Riverside. Inst. of Geophysics and Planetary Physics.

MAGNETOTAIL STRUCTURES IN A SIMULATED EARTH'S MAGNETOSPHERE

G. Yur, H. U. Rahman, J. Birn (Los Alamos National Lab., NM.), F. J. Wessel (California Univ., Irvine.), and S. Minami (Osaka City Univ., Japan.) [1993] 18 p

(Grant NAGw-2655)

(NASA-CR-193090; NAS 1.26:193090) Avail: CASI HC A03/MF A01

The structure of the magnetotail is investigated in a laboratory simulated magnetosphere. Particular emphasis is placed on the region of distant magnetotail where the closed field line region of the plasma sheet terminates and the process of reconnection takes place. Our study builds upon the previous investigation of the magnetotail where the main results were based on the magnetic field measurements in the tail region of the simulated magnetosphere. In this paper, more elaborate measurements of plasma flow and electric field are presented. Besides these measurements, this region of distant magnetotail is also explored by high resolution imaging with a gated optical imager (GOI) and by digital image analysis. These images clearly reveal a Y-type magnetic neutral line for the northward 'interplanetary' field (IMF) and a usual X-type for the southward IMF that confirms our previous results deduced from the magnetic field measurements. In the neighborhood of these neutral points a strong component of dawn to dusk electric field (E(sub y)) and a counterstreaming plasma flow is also observed. Plasma flow is measured by using a double sided Faraday cup which is also used to measure the y-component of tail current (J(sub y)) at different locations. These measurements reveal that the tail current is not carried by ions as previously thought, rather it is carried by electrons alone. Author (revised)

N93-27154*# Augsburg Coll., Minneapolis, MN.

ANALYSIS OF MAGNETOMETER DATA/WAVE SIGNALS IN THE EARTH'S MAGNETOSPHERE Final Report, 1 Apr. 1990 - 31 Mar. 1993

Mark J. Engebretson 1993 27 p Original contains color illustrations

(Grant NAG5-1325)

(NASA-CR-193169; NAS 1.26:193169) Avail: CASI HC A03/MF A01; 1 functional color page

Work on the reduction and analysis of Dynamics Explorer (DE) satellite magnetometer data with special emphasis on the ULF fluctuations and waves evident in such data is described. Research focused on the following: (1) studies of Pc 1 wave packets near the plasmapause; (2) satellite-ground pulsation study; (3) support for studies of ion energization processes; (4) search for Pc 1 wave events in 1981 DE 1 data; (5) study of Pc 3-5 events observed simultaneously by DE 1 and by AMPTE CCE; (6) support for studies of electromagnetic transients on DE 1; and (7) analysis of wave events induced by sudden impulses. CASI

N93-27284*# North Carolina State Univ., Raleigh. Dept. of Marine, Earth, and Atmospheric Sciences.

MESO-BETA SCALE NUMERICAL SIMULATION STUDIES OF TERRAIN-INDUCED JET STREAK MASS/MOMENTUM PERTURBATIONS Semiannual Report

Yuh-Lang Lin and Michael L. Kaplan May 1993 80 p Sponsored by NASA. Washington

(NASA-CR-193045; NAS 1.26:193045) Avail: CASI HC A05/MF A01

The first section is on 3-D numerical modeling of terrain-induced circulations and covers the following: (1) additional insights into gravity wave generation mechanisms based on the control simulation; (2) ongoing nested-grid numerical simulations; (3) work to be completed during the remainder of FY-93; and (4) work objectives for FY-94. The second section is on linear theory and theoretical modeling and covers the following: (1) the free response of a uniform barotropic flow to an initially stationary unbalanced (ageostrophic) zonal wind anomaly; and (2) the free response of a uniform barotropic flow to an initially stationary balanced zonal wind anomaly. Derived from text

N93-27422# Utah State Univ., Logan. Dept. of Plants, Soils, and Biometeorology.

DETERMINATION OF REGIONAL EVAPOTRANSPIRATION FROM MEASUREMENTS OF THE ATMOSPHERIC BOUNDARY LAYER Final Report

L. E. Hipps and E. Swiatek 1993 110 p

(Contract USGS-14-08-0001-G1653)

(PB93-172971) Avail: CASI HC A06/MF A02

Many surface flux experiments have been conducted at local scales over irrigated and nonirrigated agricultural fields, and over forests. These experiments have collected a vast amount of information on the microclimate, hydrological cycle, and energy balance for these areas. The information is used to make groundwater recharge estimates from which irrigation schedules and general water management practices are developed. The focus of the research is to study the local and regional values of sensible and latent heat flux in a closed desert basin typical of the Great Basin. The local scale fluxes were found by several eddy correlation stations located throughout the study site. Net radiation and soil heat flux were also measured at one site. Temporal and spatial variability in the local scale sensible and latent heat fluxes were examined. The surface fluxes were averaged to give regional flux estimates. The regional surface flux estimate was then used as the ground truth for the regional scale estimates made by the Atmospheric Boundary Layer (ABL) approaches. NTIS

N93-27483*# Michigan Univ., Ann Arbor. Dept. of Atmospheric, Oceanic and Space Science.

AN ASSESSMENT OF TWILIGHT AIRGLOW INVERSION PROCEDURES USING ATMOSPHERE EXPLORER OBSERVATIONS Final Report

I. C. McDade and W. E. Sharp (National Research Council of Canada, Ottawa, Ontario.) Apr. 1993 81 p

(Grant NAG5-1502)

(NASA-CR-193205; NAS 1.26:193205) Avail: CASI HC A05/MF A01

The aim of this research project was to test and truth some recently developed methods for recovering thermospheric oxygen atom densities and thermospheric temperatures from ground-based observations of the 7320 A O(+)((sup 2)D - (sup 2)P) twilight air glow emission. The research plan was to use twilight observations made by the Visible Airglow Experiment (VAE) on the Atmosphere Explorer 'E' satellite as proxy ground based twilight observations. These observations were to be processed using the twilight inversion procedures, and the recovered oxygen atom densities and thermospheric temperatures were then to be examined to see how they compared with the densities and temperatures that were measured by the Open Source Mass Spectrometer and the Neutral Atmosphere Temperature Experiment on the satellite. Author (revised)

N93-27612# Argonne National Lab., IL.

A HIERARCHICAL FRAMEWORK FOR COUPLING SURFACE FLUXES TO ATMOSPHERIC GENERAL CIRCULATION MODELS: THE HOMOGENEITY TEST

N. L. Miller 1993 6 p Presented at the 73rd AMS Annual Meeting, Anaheim, CA, 17-22 Jan. 1993
(Contract W-31-109-eng-38)
(DE93-004804; ANL/CP-77175; CONF-930133-7) Avail: CASI HC A02/MF A01

The atmosphere and the biosphere are inherently coupled to one another. Atmospheric surface state variables such as temperature, winds, water vapor, precipitation, and radiation control biophysical, biogeochemical, and ecological processes at the surface and subsurface. At the same time, surface fluxes of momentum, moisture, heat, and trace gases act as time-dependent boundary conditions providing feedback on atmospheric processes. To understand such phenomena, a coupled set of interactive models is required. Costs are still prohibitive for computing surface/subsurface fluxes directly for medium-resolution atmospheric general circulation models (AGCMs), but a technique has been developed for testing large-scale homogeneity and accessing surface parameterizations and models to reduce this computational cost and maintain accuracy. This modeling system potentially bridges the observed spatial and temporal ranges yet allows the incorporation of necessary details about individual ecological community types or biomes and simulates the net momentum, heat, moisture, and trace gas fluxes. This suite of coupled models is defined here as the hierarchical systems flux scheme (HSFS). DOE

N93-27703# Atomic Weapons Research Establishment, Aldermaston (England).
ANALYSIS OF SEISMOGRAMS FROM NUCLEAR EXPLOSIONS OF KNOWN YIELD AT DEGELEN MOUNTAIN AND KONYSTAN IN EAST KAZAKHSTAN, USSR
P. D. Marshall, D. Porter, and P. Peachell Feb. 1992 119 p
(AWE-O-2/92; BR308876; ISBN-0-85-518199-0; ETN-93-93781) Copyright Avail: CASI HC A06/MF A02; HMSO, 49 High Holborn, London 1, England, HC

An analysis of the P and PcP waves recorded at four medium aperture arrays from 8 explosions of known yield at Degelen Mountain and 6 at Konystan (Murzhik) in the USSR is presented. Three seismograms are illustrated for each P and PcP wave available for analysis: the Short Period (SP) array sum, the Broad Band (BB) seismogram, and the BB corrected for the effects of anelastic attenuation. The relationships between the Root Mean Square (RMS) amplitudes of selected windows of different length taken from the P and P-wave coda and yield were determined and it is demonstrated that such measurements can be used to estimate the relative sizes of explosions. For the four array station data it is demonstrated that for explosions at Degelen Mountain the RMS amplitude is a better estimate of relative source size than the conventional 1/2 peak-to-peak P-wave amplitude used to determine magnitude whereas the opposite is true for explosions at Konystan. The rise-time, fall-time, and durations of the radiated source pulse were analyzed, and the results suggest that the source scaling of the explosions is closer to (yield)(exp 1/10) than the theoretical (yield)(exp 1/3). The area of the radiated P pulse is measured to determine Psi(sub infinity) (the long term level of the reduced displacement potential), which is used to establish a relationship between yield and the maximum likelihood estimate of magnitude. Psi(sub infinity) is used to determine the seismic moment of the explosion, and a relationship between moment and yield for explosions at the two test sites is determined. ESA

N93-27833 Danish Meteorological Inst., Copenhagen. Div. of Research and Development.
BRORFELDE GEOMAGNETIC OBSERVATORY: MAGNETIC RESULTS, 1990 Annual Report
1992 27 p
(DMI-92-1; ETN-93-93778) Avail: Danish Meteorological Inst., Div. of Research and Development, 100 Lyngbyvej, DK-2100, Copenhagen, Denmark

The coordinates for the Brorfelde (Denmark) geomagnetic observatory are given and the instrumentation and methods of data reduction and distribution are described. Regular recording of the D, H, and Z geomagnetic elements takes place by means of digitally recording magnetometer systems. The observed and adapted baseline values are shown. Tables of monthly and annual mean values for the different magnetic elements are presented. ESA

N93-27834 Danish Meteorological Inst., Copenhagen. Div. of Research and Development.
GODHAVN (GREENLAND) GEOPHYSICAL OBSERVATORY: MAGNETIC RESULTS, 1985-1990
1992 90 p
(DMI-92-2; ETN-93-93779) Avail: Danish Meteorological Inst., Div. of Researh and Development, Lyngbyvej 100, DK-2100 Copenhagen, Denmark

The coordinates for the Godhavn (Greenland) geophysical observatory are given and the instrumentation and methods of data reduction and distribution are described. The Danish Meteorological Institute operates two magnetometer chains in Greenland, with three permanent observatories and a number of variation stations in the west coast, and four variation stations in the east coast. Tables of monthly and annual mean values and plots of the secular variation for the different magnetic elements are presented. ESA

N93-28004# Lawrence Livermore National Lab., CA.
EFFECTS OF CLOUD-RADIATION INTERACTIONS ON TROPOSPHERIC CHEMISTRY
K. E. Grant, A. S. Grossman, and P. S. Connell 30 Oct. 1992 4 p Presented at the International Radiation Symposium, Estonia, 3-8 Aug. 1992
(Contract W-7405-eng-48)
(DE93-003465; UCRL-JC-109681; CONF-9208185-1) Avail: CASI HC A01/MF A01

The effect of clouds on radiation fields is one of the most important areas of uncertainty and study for improvement of climate models and global tropospheric chemistry models. Concentrations of trace species whose rates of formation or destruction are dependent on the instantaneous concentration of hydroxyl radical are subject to wide fluctuations with both the diurnal cycle and the passage overhead of clouds. Such fluctuations stem from variations in the rate of photolysis of tropospheric ozone. We have used the Lawrence Livermore National Laboratory (LLNL) one-dimensional chemical-radiation-transport model as a tool to investigate the effect of cloud-radiation interactions on tropospheric chemistry. We present results showing the calculated effects of a simple perturbation of the fractional cloudiness on the tropospheric concentrations of several chemical species and on the rate of O3 photolysis. DOE

N93-28094# Technische Univ., Delft (Netherlands).
MIGRATION OF SEISMIC DATA IN THE DOUBLE RADON TRANSFORMED DOMAIN Ph.D. Thesis
Radmila Tatalovic 1992 130 p
(Contract KSEPL-97000884-EPR)
(ETN-93-93596) Copyright Avail: CASI HC A07/MF A02

A study to develop a prestack time migration algorithm and apply it to the shot oriented and double Radon transformed data is reported. The aim of migration is stated as the need to reveal the true geometry of subsurface reflectors, which consists of discontinuities in the acoustic impedance of the Earth. All existing migration methods require the velocity structure of the Earth to be known, in order to produce a reliable image of the reflectors. That is, the answer which is expected from migration, is required to be known in order to do the migration. It was this velocity paradox which inspired this study. ESA

N93-28137*# Colorado Univ., Boulder. Div. of Cryospheric and Polar Processes.
SEA ICE-ATMOSPHERIC INTERACTION: APPLICATION OF MULTISPECTRAL SATELLITE DATA IN POLAR SURFACE ENERGY FLUX ESTIMATES Annual Progress Report
Konrad Steffen, J. Key, J. Maslanik, and A. Schweiger Apr. 1993 22 p
(Grant NAGw-2158)
(NASA-CR-193027; NAS 1.26:193027) Avail: CASI HC A03/MF A01

This is the third annual report on: Sea Ice-Atmosphere Interaction - Application of Multispectral Satellite Data in Polar Surface Energy Flux Estimates. The main emphasis during the past year was on: radiative flux estimates from satellite data; intercomparison of satellite and ground-based cloud amounts; radiative cloud forcing; calibration of the Advanced Very High Resolution Radiometer (AVHRR) visible channels and comparison of two satellite derived albedo data sets; and on flux modeling for leads.

Major topics covered are arctic clouds and radiation; snow and ice albedo, and leads and modeling. Author (revised)

N93-28185# Naval Postgraduate School, Monterey, CA.
INVESTIGATION OF SYSTEMATIC EFFECTS IN ATMOSPHERIC MICROTHERMAL PROBE DATA M.S. Thesis
Daniel S. Roper Dec. 1992 105 p
(AD-A262119) Avail: CASI HC A06/MF A02

The propagation of electromagnetic radiation through the atmosphere is a crucial aspect of laser target acquisition and surveillance systems and is vital to the effective implementation of some Theater Missile Defense systems. Atmospheric turbulence degrades the image or laser beam quality along an optical path. During the past decade, the U.S. Air Force's Geophysics Directorate of Phillips Laboratory collected high speed differential temperature measurements of the atmospheric temperature structure parameter, C sub(t exp 2), and the related index of refraction structure parameter, C sub(n exp 2). The stratospheric results show a 1-2 order of magnitude increase in day turbulence values compared to night. Resolving whether these results were real or an artifact of solar contamination is a critical Theater Missile Defense issue. This thesis analyzed the thermosonde data from an experimental program conducted by the Geophysics Directorate in December 1990 and found strong evidence of solar induced artifacts in the daytime thermal probe data. In addition, this thesis performed a theoretical analysis of the thermal response versus altitude of fine wire probes being used in a new thermosonde system under development at the Naval Postgraduate School. Experimental wind tunnel measurements were conducted to validate the analytical predictions. DTIC

N93-28243# Naval Command, Control and Ocean Surveillance Center, San Diego, CA. Research, Development, Test and Evaluation Div.
A REVIEW OF THE IONOSPHERIC MODEL FOR THE LONG WAVE PREDICTION CAPABILITY Final Report
J. A. Ferguson Nov. 1992 22 p
(AD-A262283; NCCOSC/RDT/E-TR-2393) Avail: CASI HC A03/MF A01

The Naval Command, Control, and Ocean Surveillance Center's Long Wave Prediction Capability (LWPC) has a built-in ionospheric model. The latter was defined after a review of the literature comparing measurements with calculations. Subsequent to this original specification of the ionospheric model in the LWPC, a new collection of data were obtained and analyzed. The new data were collected aboard a merchant ship named the Callaghan during a series of trans-Atlantic trips over a period of a year. This report presents a detailed analysis of the ionospheric model currently in use by the LWPC and the new model suggested by the shipboard measurements. We conclude that, although the fits to measurements are almost the same between the two models examined, the current LWPC model should be used because it is better than the new model for nighttime conditions at long ranges. This conclusion supports the primary use of the LWPC model for coverage assessment that requires a valid model at the limits of a transmitter's reception. DTIC

N93-28249 Florida State Univ., Tallahassee.
DETERMINING THE SURFACE HEAT FLUX DISTRIBUTION OVER THE TROPICAL PACIFIC OCEAN BY THE ADJOINT METHOD Ph.D. Thesis
Lisan Yu 1992 178 p
Avail: Univ. Microfilms Order No. DA9309744

The parameter optimization problem in oceanography in which an oceanic model with thermodynamics is used to determine the surface thermal forcing field by the adjoint technique, is studied. Two data sets are chosen, the climatological monthly-mean sea surface temperature (SST) and winds. The seasonal variability of the surface heat flux distribution over the tropical Pacific ocean is investigated. The use of a priori information is investigated in the formulation of the cost function. Experimental evidence has verified that adding a priori information of the estimated parameters can increase the probability for the solution to be unique. The a priori information also plays the role of bogus data. It serves not only to increase the number of observations but to improve the conditioning of the Hessian. The results are very promising. It has been possible, for the first time, to calculate the seasonal surface heat flux patterns which are consistent with both the ocean's physics and the observations. Dissert. Abstr.

N93-28308# Naval Command, Control and Ocean Surveillance Center, San Diego, CA.
AURORAL-E OBSERVATIONS: THE FIRST YEAR'S DATA Final Report, Aug. 1991 - Aug. 1992
R. B. Rose and R. D. Hunsucker Feb. 1993 73 p
(AD-A263158; NCCOSC/RDT/E-TD-2449) Avail: CASI HC A04/MF A01

Personnel at the Naval Command, Control and Ocean Surveillance Center, RDT and E Division, and RP Consultants conducted a year-long study to measure and characterize auroral-E propagation. Personnel installed a 100-watt transmitter at the Arctic Submarine Laboratory at Cape Prince of Wales (67 N, 168 W) and a receiver at RP Consultants' facilities 900 kilometers away. Both sites used simple dipole antennas. The transmitter sent a slow morse R on a frequency of 25.545 megahertz (MHz). Only a very dense patch of ionization, typical of sporadic-E or auroral-E with foEs greater than 5 MHz, would sustain a sky-wave signal over this path. The solar sunspot number declined from 175 to less than 100 during the test period. Personnel recorded over 1400 auroral sporadic-mode observations whose durations spanned 1 minute to several hours. A strong diurnal dependence was noted. This document presents an initial characterization of auroral-E occurrences, noting time of day, season, and magnetic activity. It discusses some implications of auroral-E occurrence intensity. The data are also discussed with respect to the development of a new auroral-E expert system model. DTIC

N93-28379# Aerospace Corp., El Segundo, CA. Space Sciences Lab.
HANDBOOK FOR THE USAF SPACE ENVIRONMENT STANDARD (MIL-STD-1809)
Jan. 1993 70 p
(AD-A262799; AD-E201446; PL-TR-93-2010; SR-2) Avail: CASI HC A04/MF A01

The Handbook for the Space Environment Standard (MIL-STD-1809) is a companion document to the Standard. The Standard is necessarily a very concise document, so that the Handbook is intended to make its usage easier. The Handbook describes the sources of the environmental models cited in the Standard, as well as the usage of the models, and their limitations. Means for obtaining the cited models are given as well. With the exception of the space debris model, the Handbook covers only the natural space environment. The Handbook provides a general overview of the various components of the space environment and the generally accepted understanding of them at the current time. A bibliography is provided to aid in understanding the materials presented in the Handbook and Standard. DTIC

N93-28380# Boston Coll., Chestnut Hill, MA. Inst. for Space Research.
KINETIC STUDIES OF IONOSPHERIC TRANSPORT IN THE POLAR CAP AND AURORAL ZONE Final Report, 6 Jul. 1988 - 30 Dec. 1992
Dwight T. Decker 3 Nov. 1992 34 p
(Contract F19628-88-K-0008)
(AD-A262805; AD-E201437; BS-ISR-93-01; PL-TR-92-2286) Avail: CASI HC A03/MF A01

We have studied and modeled several of the important coupling processes that involve particle and energy flow into and within the ionosphere in the polar cap and auroral zone. Understanding these coupling processes helps us better understand the response of the polar ionosphere to external stimuli, and thus helps us understand its structure and day-to-day variability. Modern models of the inner magnetosphere require an accurate treatment of ionospheric precipitation and backscatter to properly describe the population of the plasma sheet. We have developed a detailed kinetic model of the electron population in the inner portion of the magnetosphere including the effects of convection, pitch angle scattering, precipitation, and backscatter. Using numerical solutions of an electron transport equation with appropriate boundary conditions and sunlit polar cap observations, we find that two energetic electron populations (photoelectron and polar rain) are present and are needed to explain polar cap observations. Recently, the first self-consistent theory for the combined electron-proton-hydrogen atom aurora has been developed. We present the first test of this fully coupled three species transport model. Two dimensional plasma simulations and Monte Carlo simulations have been used to calculate the heating of the ions and electrons as well as the temporal evolution of plasma waves in the suprauroral region. E and F region fluid models have been developed

and tested against various observations. We find that our models reproduce much of the observed climatology. DTIC

N93-28384# Connecticut Univ., Storrs. Dept. of Geology and Geophysics.
CRUSTAL AND UPPER MANTLE VELOCITY GRADIENTS IN THE VICINITY OF THE EAST KAZAKH TEST SITE: RAY SYNTHESIS OF Lg IN THREE-DIMENSIONAL CRUSTAL MODELS Final Report, 1 Sep. 1990 - 19 Oct. 1992
Vernon F. Cormier, Michael D. Kalmbach, and Hanjie Zhao 30 Oct. 1992 29 p
(Contract F19628-90-K-0043)
(AD-A263209; PL-TR-92-2305) Avail: CASI HC A03/MF A01

Using a simple homogeneous crust and a first order Moho discontinuity, Lg waveforms are synthesized in canonical models as well as models chosen for selected Eurasian paths. Lg blockage by basins and Moho transitions is a strong function of the slope of the Moho surface and is only a weak function of the angle of source-receiver path relative to the strike of the structure. Synthetic waveforms are often in good qualitative agreement with observed waveforms, including details in the shape of the Lg coda. Poorer agreement is seen in cases in which either the inferred Moho from surface topography disagrees with that determined from deep seismic sounding observations, or sedimentary basin structure is not included in the synthetic modeling. Synthetics that allow single scattering incorporated by the Born approximation show that scattering by heterogeneity within the crustal waveguide can fill up the Lg coda between multiple SmS arrivals and lengthen the Lg coda. The trajectories and geometric spreading of rays contributing to Lg suggest that the most important effects of scattering will be concentrated in the Moho transition and in the upper several kilometers of the crust. DTIC

N93-28385# Atmospheric and Environmental Research, Inc., Cambridge, MA.
RADTRAN WITH SPHERICAL-REFRACTIVE GEOMETRY Technical Report
William Gallery and Ronald Isaacs 22 Dec. 1992 39 p
(Contract F19628-91-C-0011)
(AD-A263213; PL-TR-93-2004; SR-3) Avail: CASI HC A03/MF A01

RADTRAN is a model and computer program for computing atmospheric transmittance and radiance in the microwave region. The previous version of RADTRAN assumed a plane parallel non-refracting atmosphere for computing the amounts of absorbers and scatterers (e.g. oxygen, water vapor, clouds, rain) along the optical path. However, the plane-parallel assumption breaks down for zenith angles greater than about 80 degrees, leading to large errors in the calculated radiance and transmittance. The standard Phillips Lab atmospheric raytrace model FSCATM has been incorporated into RADTRAN as an option to calculate the absorber amounts. FSCATM uses spherical. refractive geometry to compute the layer-by-layer absorber amounts and density-weighted pressure and temperature for any slant path through the atmosphere. The atmospheric profiles from RADTRAN are retained. In the new program, called RADTRANS, the spherical-refractive geometry is available as an option, otherwise the program retains all the capabilities of the original version. However, the spherical geometry is incompatible with the multiple scattering model so the multiple scattering calculations must still be run using the plane-parallel geometry. Sample calculations are shown for the case of a satellite sensor scanning the nadir from 890 km. The radiance and the transmittance are calculated for 37, 90, and 150 GHz for both spherical and plane parallel geometries. The results show differences of up to 70 K in brightness temperature at 37 GHz out near the horizon. DTIC

47 METEOROLOGY AND CLIMATOLOGY

Includes weather forecasting and modification.

N93-26630# Naval Research Lab., Monterey, CA.
A PROTOTYPE CLIMATE INFORMATION SYSTEM Final Report
T. K. Jarrett Jan. 1993 77 p
(AD-A261799; NRL/FR/7541-92-9405) Avail: CASI HC A05/MF A01

This report describes a prototype Climate Information System (CIS) developed by the Atmospheric Directorate of the Naval Research Laboratory Detachment for use on the Tactical Environmental Support System, TESS(3). The climatic data requirements for TESS(3) are listed and the CIS design rationale and implementation methodology are documented. The CIS computer software reduces the time and effort required to locate, ingest, and analyze climatic data. The CIS remedies accessibility problems of existing climatologies by using a data base management system to manage on-line data sets. The use of compact computer media allows a wide range of climatic data to be distributed to Navy ships and facilities that would otherwise lack the necessary storage space. The CIS computer graphics capability improves data comprehension by remapping data to common projections. The CIS capabilities are demonstrated with sample data sets that partially meet the TESS(3) requirements. Data sources for the remaining requirements are cited when they could be found, but meeting some requirements will require development of new climatologies. The CIS design allows addition of data sets as they become available. DTIC

N93-26991# Meteorological Satellite Center, Tokyo (Japan).
METEOROLOGICAL SATELLITE CENTER TECHNICAL NOTE, NO. 25, 1992
Nov. 1992 103 p In JAPANESE Original contains color illustrations
(MSC-TN-25) Avail: CASI HC A06/MF A02

Papers on the following topics are presented: (1) the representativeness of various clouds as tracers of the flow; (2) the relationship between satellite-derived cloud parameters and measured maximum wind speed in the typhoon genesis stage; (3) data collection platform communication link monitoring program; (4) a comparison of geostationary meteorological satellite low-level cloud motion winds sea surface winds observed by ships over western part of the North Pacific Ocean; (5) a usage and maintenance of meteorological satellite data; and (6) derivation of total ozone amount from NOAA/TOVS data. For individual titles, see N93-26992 through N93-26997.

N93-26992# Meteorological Satellite Center, Tokyo (Japan).
THE REPRESENTATIVENESS OF VARIOUS CLOUDS AS TRACERS OF THE FLOW
Takao Imaizumi *In its* Meteorological Satellite Center Technical Note, No. 25, 1992 Nov. 1992 p 1-13 (For primary document see N93-26991 10-47)
Avail: CASI HC A03/MF A02

High cloud motion winds (CMW) are classified according to their cloud patterns and individually compared with collocated radiosonde winds to confirm the representativeness of various clouds as tracers of the flow. As a result, the relationship between cloud characteristics and their ability to trace the flow is obtained. Case studies show that thin cirrus in clear shape traces the flow at a single level as exactly as a radiosonde even in jet stream areas. Such cirrus often traces the jet stream axis. If height assignment error and tracking error do not exist, no significant difference occur in their wind speed or direction between th CMW's obtained from suitable tracer clouds and radiosonde winds. Therefore, a negative speed bias of CMW's and speed dependency of the bias found in the statistical comparison between CMW's and radiosonde winds are not consistent features pertinent to all CMW's. Rogue CMW's obtained from tracers of thick clouds mainly cause the negative speed bias. Cloud texture analysis and thinness of cloud can provide information on the quality of a tracer.
Author (revised)

N93-26993# Meteorological Satellite Center, Tokyo (Japan).
THE RELATIONSHIP BETWEEN SATELLITE-DERIVED CLOUD PARAMETERS AND MEASURED MAXIMUM WIND SPEED IN THE TYPHOON GENESIS STAGE
Yoshiyuki Abe, Yoshihisa Makino, Koetsu Chubachi, and Tadayoshi Ueno *In its* Meteorological Satellite Center Technical Note, No. 25, 1992 Nov. 1992 p 15-43 In JAPANESE (For primary document see N93-26991 10-47)
Avail: CASI HC A03/MF A02

The Tropical Cyclone Analysis Working Group in the Meteorological Satellite Center has been promoting a subject for the technological development on the typhoon genesis judgment using Geostationary Meteorological Satellite (GMS) imagery since 1989 in cooperation with the RSMC Tokyo Typhoon Center. The main purpose of this development is to establish the bases and method which can suggest the possibility of

typhoon genesis roughly within 24 hours before using GMS infrared imagery. Next themes were aimed in the investigation for the technological development. Author (revised)

N93-26994# Meteorological Satellite Center, Tokyo (Japan).
DCP COMMUNICATION LINK MONITORING PROGRAM
Yukio Sasaki, Hiroyuki Suzuki, and Hideaki Fujita *In its* Meteorological Satellite Center Technical Note, No. 25, 1992 Nov. 1992 p 45-61 In JAPANESE (For primary document see N93-26991 10-47)
Avail: CASI HC A03/MF A02

Data Collection Platform (DCP) communication link monitoring program is developed to monitor DCP signal spectrum and to check the reported data from each DCP channel effectively. This program enables the measuring system which is composed of spectrum analyzer, frequency counter, personal computer etc., to evaluate the quality of DCP communication link and the receiving (DCP) data, automatically. Hard wear conditions, functions of this program, and analyzing method of measured data are described. Author (revised)

N93-26995# Meteorological Satellite Center, Tokyo (Japan).
A COMPARISON OF GMS LOW-LEVEL CLOUD MOTION WINDS WITH SEA SURFACE WINDS OBSERVED BY SHIPS OVER WESTERN PART OF THE NORTH PACIFIC OCEAN
Haruo Taguchi *In its* Meteorological Satellite Center Technical Note, No. 25, 1992 Nov. 1992 p 63-71 In JAPANESE (For primary document see N93-26991 10-47)
Avail: CASI HC A02/MF A02

In order to use the low-level Cloud Motion Winds (CMW's) derived from Geostationary Meteorological Satellite (GMS) imageries as a reference data for wind warnings over the sea area where conventionally acquired data were sparse, the relation between low-level CMW's and Ship Observed Winds (SOW's) located over the western part of the North Pacific Ocean in winter 1991 was examined. The SOW's under the condition of cold air advection were carefully selected and checked considering the consistency of consecutive observations within 6 hours. The low level CMW's were calculated through automatic procedure. The root mean square of speed difference and the mean speed bias between CMW using visible (infrared) imageries and SOW were 1.9 (2.1) and 0.2 (0.7) m/s, respectively. The root mean square of direction difference was 14 deg(15). These results show that the low level CMW's provide useful information to forecaster who is in charge of issuing wing warnings over above-mentioned area. Author

N93-26996# Meteorological Satellite Center, Tokyo (Japan). Working Group on Data Archiving.
A USAGE AND MAINTENANCE OF METEOROLOGICAL SATELLITE DATA **c82**
In its Meteorological Satellite Center Technical Note, No. 25, 1992 Nov. 1992 p 73-87 In JAPANESE (For primary document see N93-26991 10-47)
Avail: CASI HC A03/MF A02

The actual status of utilizing the satellite digital data stored in Meteorological Satellite Center was investigated and the several problems of the data archiving were considered. Results show that the original digital data of VISSR account for most of the data utilized in other organizations. Moreover it revealed the following problems: the lack of value judgment of the data on determinating the storage period; the lack in uniformity of data format; and the lack of the maintenance of medium. Steps should be taken to meet these problems as immediately as possible. Author (revised)

N93-26997# Meteorological Satellite Center, Tokyo (Japan).
DERIVATION OF TOTAL OZONE AMOUNT FROM NOAA/TOVS DATA **c45**
Yoshito Yoshizaki *In its* Meteorological Satellite Center Technical Note, No. 25, 1992 Nov. 1992 p 89-105 In JAPANESE Original contains color illustrations (For primary document see N93-26991 10-47)
Avail: CASI HC A03/MF A02

A regression method is applied to derive the total ozone amount from TOVSHIRS/2data of NOAA meteorological satellite received at Meteorological Satellite Center. Regression coefficients are determined against Dobson measurements at Sapporo, Tateno, Kagoshima, and Naha. The total ozone amounts derived from TOVS data of NOAA 10 are analyzed for March 1988 - February 1990. Horizontal distribution of the total ozone amount around Japan are obtained and compared with the GRID-TOMS data of NIMBUS-7 satellite. Good agreements are seen between the ozone amounts derived from TOVS and TOMS. Author (revised)

N93-27015*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
NEWLY FOUND EVIDENCE OF SUN-CLIMATE RELATIONSHIPS
Hongsuk H. Kim and Norden E. Huang Apr. 1993 32 p Original contains color illustrations
(RTOP 925-00-00)
(NASA-TM-104583; NAS 1.15:104583; Rept-93B00059) Avail: CASI HC A03/MF A01; 1 functional color page

Solar radiation cycles drive climatic changes intercyclically. These interdecadal changes were detected as variations in solar total irradiances over the time period of recorded global surface-air-temperature (SAT) and have been restored utilizing Earth Radiation Budget Channel 10C measurements (1978-1990), Greenwich Observatory faculae data (1874-1975), and Taipei Observatory Active Region data (1964-1991). Analysis of the two separate events was carried out by treating each as a discrete time series determined by the length of each solar cycle. The results show that the global SAT responded closely to the input of solar cyclical activities, S, with a quantitative relation of $T = 1.62 * S$ with a correlation coefficient of 0.61. This correlation peaks at 0.71 with a built-in time lag of 32 months in temperature response. Solar forcing in interannual time scale was also detected and the derived relationship of $T = 0.17 * S$ with a correlation coefficient of 0.66 was observed. Our analysis shows derived climate sensitivities approximately fit the theoretical feedback slope, 4T(sup 3). Author (revised)

N93-27095# National Severe Storms Lab., Norman, OK. Forecast Applications Research Group.
INVESTIGATION OF OUTFLOW STRENGTH VARIABILITY IN FLORIDA DOWNBURST PRODUCING STORMS Final Report
J. T. Johnson, Michael Eilts, Kevin Droegemeier, Conrad Ziegler, ed., and Jerry Straka, ed. (Oklahoma Univ., Norman.) Feb. 1993 113 p Original contains color illustrations
(DOT/FAA/NR-93/5) Avail: CASI HC A06/MF A02

With the Federal Aviation Administration introducing Doppler weather radar to high-traffic airports in the form of the Terminal Doppler Weather Radar (TDWR), improved identification of dangerous windshears from downbursts and other weather phenomena will be possible. Using detection and prediction algorithms, the TDWR system will give controllers and pilots more information about the weather situation in the terminal area than is available heretofore. During the summer of 1990, a prototype TDWR system was tested and evaluated in Orlando, Florida with more than 500 downbursts detected. Many storms possessing apparently 'similar' characteristics were found to produce a wide variety of outflow speeds on days with nearly the same environmental structure. Single-Doppler radar observations, surface mesonet data, and a 3-D numerical cloud model were used in an attempt to determine causes for the observed variability. In particular, 8 downbursts from August 18, 21, and 22 as well as 5 simulated downbursts were examined. Our results show that the observed variability is explained neither by Doppler radar signatures known to precede downbursts (e.g., convergence and rotation aloft) nor by minor but detectable variations in the environment among the three days examined. Suspecting somewhat more subtle mechanisms, detailed microphysical processes within numerically simulated storms were examined. Though three important regimes associated with downburst production (above melting level, between melting level and cloud base, and below cloud base) were identified, no clear ties were found between microphysics variations and the intensity of the outflows. By eliminating the above mechanisms, we reason that the observed variability, which at times is quite significant, could perhaps be explained by very shallow surface-based stable layers whose principle effect would be to diminish outflow intensity through dispersion of energy by gravity waves. Numerical simulations of clouds growing in such environments verified this hypothesis, and showed that although updraft and downdraft intensity are virtually unaffected relative to a non-stable-layer simulation, the resulting outflow speed can be reduced by as much as 40 percent. Author (revised)

N93-27262*# Florida State Univ., Tallahassee.
AN EVALUATION OF SATELLITE-DERIVED HUMIDITY AND ITS RELATIONSHIP TO CONVECTIVE DEVELOPMENT Final Report, Dec. 1987 - Dec. 1992
Henry E. Fuelberg May 1993 276 p
(Grant NAG8-653)
(NASA-CR-193077; NAS 1.26:193077; FSU-ID-1338-580-26) Avail: CASI HC A13/MF A03

An aircraft prototype of the High-Resolution Interferometer Sounder (HIS) was flown over Tennessee and northern Alabama during summer 1986. The HIS temperature and dewpoint soundings were examined on two flight days to determine their error characteristics and utility in mesoscale analyses. Random errors were calculated from structure functions while total errors were obtained by pairing the HIS soundings with radiosonde-derived profiles. Random temperature errors were found to be less than 1 C at most levels, but random dewpoint errors ranged from 1 to 5 C. Total errors of both parameters were considerably greater, with dewpoint errors especially large on the day having a pronounced subsidence inversion. Cumulus cloud cover on 15 June limited HIS mesoscale analyses on that day. Previously undetected clouds were found in many HIS fields of view, and these probably produced the low-level horizontal temperature and dewpoint variations observed in the retrievals. HIS dewpoints at 300 mb indicated a strong moisture gradient that was confirmed by GOES 6.7-micron imagery. HIS mesoscale analyses on 19 June revealed a tongue of humid air stretching across the study area. The moist region was confirmed by radiosonde data and imagery from the Multispectral Atmospheric Mapping Sensor (MAMS). Convective temperatures derived from HIS retrievals helped explain the cloud formation that occurred after the HIS overflights. Crude estimates of Bowen ratio were obtained from HIS data using a mixing-line approach. Values indicated that areas of large sensible heat flux were the areas of first cloud development. These locations were also suggested by GOES visible and infrared imagery. The HIS retrievals indicated that areas of thunderstorm formation were regions of greatest instability. Local landscape variability and atmospheric temperature and humidity fluctuations were found to be important factors in producing the cumulus clouds on 19 June. HIS soundings were capable of detecting some of this variability. The authors were impressed by HIS's performance on the two study days. Author

N93-27292*# Colorado State Univ., Fort Collins. Dept. of Atmospheric Science.
CSU FIRE 2 CIRRUS FIELD EXPERIMENT: DESCRIPTION OF FIELD DEPLOYMENT PHASE
S. Cox, G. Beck, C. Cornwall, J. Davis, P. Hein, C. Lappen, R. Song, J. Withrow, D. Wood, and J. Alvarez (National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.) et al Aug. 1992 85 p
(Contract NAG1-1146; N00014-91-J-1422)
(NASA-CR-193162; NAS 1.26:193162; FIRE-Ser-8; Atmospheric-Sci-Paper-506) Avail: CASI HC A05/MF A01

The Colorado State University (CSU) surface observing systems are described. These systems were deployed at the Parsons, Kansas site during the FIRE 2 Cirrus Special Observing Period (SOP) from 13 Nov. - 7 Dec. 1991. The geographical coordinates of the site containing most of the CSU instrumentation are 37 deg. 18 min N. latitude and 96 deg. 30 min. W. longitude; site elevation was 269 meters. In addition, one surface meteorological and broadband flux observing site was maintained at the Tri City Airport which is approximately 18 miles due west of Parsons (37 deg. 20 min. N. latitude, 95 deg. 30 min. 30 sec. W. longitude). A map of the locations of the CSU deployment sites is presented. At the main Parsons site, the instrumentation was located directly adjacent to and north of a lake. Under most cirrus observing conditions, when the wing had a significant southernly component, the lake was upwind of the observing site. The measurements and observations collected during the experiment are listed. These measurements may be grouped into five categories: surface meteorology; infrared spectral and broadband measurements; solar spectral and broadband measurements; upper air measurements; and cloud measurements. A summary of observations collected at the Parsons site during the SOP are presented. The wind profiler, laser ceilometer, surface meteorology and surface broadband radiation instrumentation were operated on a continuous basis. All other systems were operated on an 'on demand' basis when cloud conditions merited the collection of data. Derived from text

N93-27407# National Oceanic and Atmospheric Administration, Silver Spring, MD. Air Resources Lab.
ACE 1992 SUMMARY DATA REPORT: AIRCRAFT MEASUREMENTS OF METEOROLOGICAL PARAMETERS AND SF6
B. A. Watkins, J. F. Boatman, D. L. Wellman, and S. W. Wilkison Feb. 1993 110 p See also PB90-107145
(PB93-174886; NOAA-TM-ERL-ARL-200) Avail: CASI HC A06/MF A02

Meteorological parameters and sulfur hexafluoride (SF6) were measured with the NOAA King Air C-90 aircraft during October 1992 in central Florida as part of the Air Force Technical Applications Command (AFTAC) Airborne Collection Equipment (ACE 1992) experiment. Airborne sampling was used to locate a plume containing SF6 as a tracer. Before take off, a trajectory model was used to provide the expected plume path. An onboard tracking program gave current predictions of the location of the plume, based on the location of tetroons expected to travel with the plume. Once the plume was located, samples were collected of triethyl phosphate oxide and methyl salicylate, which had been released with the SF6. This report discusses the objectives of ACE 1992, the instrumentation used and the data obtained by the NOAA King Air ground and airborne operation. NTIS

N93-27516# National Oceanographic Data Center, Washington, DC.
MARINERS WEATHER LOG, VOLUME 37, NUMBER 1, WINTER 1993 Quarterly Report
R. M. DeAngelis 1993 106 p See also PB93-132041
(PB93-174308) Avail: CASI HC A06/MF A02

The contents are as follows: The Horror of Great Hurricanes (The Big One is still out there); NEXRAD Now (The Doppler Radar is helping to revolutionize warnings); Typhoon Aquarius (A courageous crew battle Typhoon Nat to save lives); VOS--Southern Hemisphere (How the VOS program is providing ocean wide climate data); and Key Largo National Marine Sanctuary (Born out of ecological destruction, the sanctuary is now a haven for creatures of the sea). NTIS

N93-27534# Colorado State Univ., Fort Collins. Dept. of Atmospheric Science.
FORECAST OF ATLANTIC SEASONAL HURRICANE ACTIVITY FOR 1993
William M. Gray 4 Jun. 1993 18 p Sponsored by NSF and NOAA
Avail: CASI HC A03/MF A01

This paper presents details of the author's forecast for the amount of tropical cyclone activity expected to occur in the Atlantic Ocean region, including the Caribbean Sea and the Gulf of Mexico, during 1993. This forecast is based on ongoing research relating the amount of seasonal Atlantic tropical cyclone activity to five basic forecast parameters. These are: (1) the Quasi-Biennial Oscillation (QBO) of equatorial stratospheric wind; (2) the El Nino Southern Oscillation (ENSO); (3) West African Rainfall (AR) anomalies of the previous year; (4) West African west to east gradients of anomalous surface pressure and surface temperature (APT) during Feb. through May; and (5) Caribbean Basin Sea Level Pressure and Upper Level Zonal Wind Anomalies (SLPA and ZWA respectively). Information received by the author through 3 Jun. 1993 indicates that the 1993 hurricane season should be an average season with about 7 hurricanes, 11 named storms of at least tropical storm intensity, a total of about 25 hurricane days, 55 named storm days, and total Hurricane Destruction Potential (HDP) of 65. It is also expected that there should be two major hurricanes of Saffir/Simpson intensity category 3, 4, or 5 this season and about 3 intense hurricane days. These parameters represent an overall measure of hurricane activity about 95 percent of the last 42-year average. The amount of intense or major hurricane activity has been reduced from that given in the author's 24 Nov. 1992 forecast. This reduction is due to the slow dissipation of the current El Nino and to new estimates of West African drought conditions. Hurricane activity in 1993 will be enhanced by favorable stratospheric QBO westerly phase winds and low values of Caribbean Basin sea level pressure. It will be reduced by expected West Sahel drought conditions, and by a weakening El Nino event. The November forecast had anticipated cold ENSO conditions. Author (revised)

N93-27611# Los Alamos National Lab., NM.
ENERGY BALANCE COMPONENTS OF IRRIGATED CROPS IN NORTH-CENTRAL OREGON
F. J. Barnes, W. Porch, S. Tarbox, K. E. Kunkel, R. Scott, W. A. Dugas, and R. Hicks 1992 8 p Presented at the 73rd AMS Annual Meeting, Anaheim, CA, 17-22 Jan. 1993
(Contract W-7405-eng-36)
(DE93-003704; LA-UR-92-3274; CONF-930133-5) Avail: CASI HC A02/MF A01

Further development of general circulation models (GCM) will depend in part on incorporation of surface-vegetation-atmosphere transfer schemes (SVATS) that more accurately represent the processes at the surface of the Earth. Surface characteristics control partitioning of the radiation balance components and can be responsible for generating mesoscale circulation patterns. However, a major concern for the parameterization of a SVATS submodel is the spatial and temporal variability of the processes at the submodel and GCM scales. Detailed measurements of fluxes, hydrologic balance components, vegetation and topography are needed over several scales within a region in order to devise aggregating schemes appropriate for mesoscale and GCM grid scales. To address these issues, a cooperative measurement campaign was conducted in 1991 and 1992 by the Atmospheric Radiation Measurement (ARM) Program of the Department of Energy. Our goals during these campaigns were to measure surface flux over a range of scales and to examine the aggregation of the flux measurements to provide a regional representation of the surface characteristics for us in mesoscale models and GCMs. DOE

N93-27636 Royal Netherlands Meteorological Inst., De Bilt. Dynamical Meteorology Div.
TECHNICAL DESCRIPTION LAM AND OI: LIMITED AREA MODEL AND OPTIMUM INTERPOLATION ANALYSIS, SECOND EDITION
Wim C. deRooy and Leo M. Hafkenscheid 9 Jan. 1992 76 p
(KNMI-TR-134a; ISBN-9-03-692011-6; ETN-93-93587) Copyright Avail: Royal Netherlands Meteorological Inst., Postbus 201, 3730 AE De Bilt, Wilhelminalaan 10, Netherlands

A technical description of the software needed to run the LAM (Limited Area Model) system, is given. This includes Optimum Interpolation (OI) analysis, initialization, and the LAM forecast model--a numerical weather prediction model for the intermediate range (6 to 24 hours). The information is intended for use of programmers and scientists in charge of the LAM/OI system. ESA

N93-27663# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
INCLUDING MAXIMUM SUSTAINED WIND SPEED IN A TIME SERIES MODEL TO FORECAST HURRICANE MOVEMENT M.S. Thesis
Timothy B. Mott Mar. 1993 154 p LIMITED REPRODUCIBILITY: More than 20% of this doument may be affected by microfiche quality
(AD-A262510; AFIT/GOR/ENS/93M-14) Avail: CASI HC A08/MF A02

Techniques for applying time series fundamentals to forecasting hurricane movement are thoroughly examined in this research. The objectives are: (1) to modify Dr. Thomas Curry's threshold autoregressive time series model to improve its ability to forecast hurricane movement, (2) to forecast the maximum sustained wind speed for a hurricane, and (3) to identify if wind speed should be included as an explanatory variable to aid in forecasting hurricane movement. Eleven different models to predict the latitude, longitude and maximum sustained wind speed are compared and contrasted with Curry's bivariate time series model. The results showed the modifications allow significant forecasting improvement to Curry's model in the 6-, 12-, 24-, 48- and 72-hour forecasts. The model recommended by this research shows a significant improvement in mean and variance of the overall forecast errors. DTIC

N93-27675# National Center for Atmospheric Research, Boulder, CO.
A STATISTICAL CHARACTERIZATION OF DENVER-AREA MICROBURSTS Final Report
Kimberly L. Elmore and John McCarthy Dec. 1992 55 p Revised
(Contract DTFA01-82-Y-10513)
(AD-A262127; DOT/FAA/NR-92/13-Rev; XH-DOT/FAA/NR) Avail: CASI HC A04/MF A01

This document describes statistical characteristics of microbursts that occurred in the Denver area during the summers of 1982 and 1984. The Joint Airport Weather Studies (JAWS) Project, conducted between 15 May and 13 August 1982, is the primary data source for this report, and radar data from the Classify, Locate and Avoid Wind Shear (CLAWS) Project are also included for microburst lines and low-reflectivity microbursts. All surface mesonet data come from the JAWS Project. This report describes the statistical characteristics of the JAWS and CLAWS data that have been analyzed to date and is intended to be used as a working document. It is primarily a compendium of several different sources brought together in a single document. DTIC

N93-27831# National Defence Research Establishment, Umea (Sweden). NBC-Defence Dept.
SEA BREEZE SIMULATION WITH A STATIC PROFILE OF THE EDDY VISCOSITY
Erik Naeslund, Edvard Karlsson, and Lennart Thaning Dec. 1991 17 p Presented at PHOENICS User Conference, Nov. 1990
(FOA-B-40415-4.5; ETN-93-93760) Avail: CASI HC A03/MF A01

Mesoscale meteorological modeling with PHOENICS is addressed, with the aim of showing that PHOENICS can simulate a mesoscale flow and that the results are qualitatively consistent with previous work. Thus, a thermally driven circulation in the lower atmosphere (a sea breeze) is simulated by using a static but nonuniform turbulent viscosity. The results show reasonably good agreement in comparison with observational data as well as with earlier simulations. The PHOENICS computer code is concluded to be a powerful tool in the modeling of mesoscale meteorological phenomena, where the effect of the gravitational force must be taken into account. ESA

N93-27949# Naval Research Lab., Monterey, CA.
A SYNOPTIC COMPARISON OF SPECIAL SENSOR MICROWAVE/IMAGER DISPLAYS WITH NUMERICAL PRODUCTS Final Report
Thomas F. Lee and James S. Boyle Jan. 1993 125 p
(AD-A261960; NRL/FR/7541-92-9403; NOARL-34) Avail: CASI HC A06/MF A02

Marine environmental products from the Special Sensor Microwave/Imager (SSM/I) are compared with analyses from an operational numerical forecast system. The SSM/I products considered are windspeed, precipitable water, and precipitation. The SSM/I products give a finer representation of spatial detail than the forecast system products. In particular, the SSM/I windspeeds can be used to examine continental influences on marine windspeeds. Such mesoscale effects are not analyzed well by global numerical models. However, the output from the numerical forecast system can provide parameters not available from the SSM/I products, such as wind direction. In addition, forecast system output can provide information between satellite passes and in regions contaminated by precipitation on SSM/I products. DTIC

N93-28115# Colorado State Univ., Fort Collins. Dept. of Electrical Engineering.
MULTIPARAMETER RADAR AND AIRCRAFT BASED STUDIES OF THE MICRO-PHYSICAL, KINEMATIC AND ELECTRICAL STRUCTURE OF CONVECTIVE CLOUDS Annual Report, 15 Feb. 1992 - 15 Feb. 1993
V. N. Bringi and I. J. Caylor 14 Feb. 1993 15 p
(Grant AF-AFOSR-0141-91)
(AD-A262673; AFOSR-93-0198TR) Avail: CASI HC A03/MF A01

Ongoing studies of the microphysical kinematic and electrical evolution of two convective clouds observed by radar and aircraft during the Convective and Precipitation Electrification Project (CaPE) are reported. A complete life-cycle of cloud evolution from radar first echo to mature phase is documented using reflectivity (ZH) and differential reflectivity (ZDp). Aircraft data from T-28, NOAA-P3, NCAR King Air and Wyoming King Air are in the process of being analyzed for particle type, electric field from field mills and up/down draft. Surface field mills and LLP data give an indication of first cloud-to-ground lightning time and location. Another on-going study is related to multiparameter radar studies of lightning echoes and a triggered lightning event. DTIC

N93-28116# Air Force Systems Command, Wright-Patterson AFB, OH. Foreign Aerospace Science and Technology Center.
HANDBOOK ON THE CLIMATE OF THE USSR. ISSUE 14: GEORGIAN SSR, PART 5: CLOUD CONDITIONS AND ATMOSPHERIC PHENOMENA

11 Mar. 1993 541 p Transl. into ENGLISH from Spravochnik po Klimatu SSSR (USSR), pt. 5, no. 14, 1970 p 1-32
(AD-A262676; FASTC-ID(RS)T-0837-92) Avail: CASI HC A23/MF A04

Handbook on the Climate of USSR, iss. 14, part 5 reports the condition of clouds and atmospheric phenomena of territory of the Georgian SSR, including Abkhazian and Adzhar ASSR and South-Ossetian autonomous region, for the period from 1936 through 1965, and within section 5 hail - from 1891 through 1965. Material is represented in the form of tables on separate stations with explanatory text for each table or group of tables, similar to the method processing. A short description of the general norms and corresponding characteristic conditions of cloud conditions and atmospheric phenomena is contained in the text part of the present issue. DTIC

N93-28134# National Weather Service, Fort Worth, TX.
AIRMASS MODIFICATION BY VERTICAL MOTION: DISCUSSION AND CASE STUDY
I. S. Brenner Mar. 1993 22 p
(PB93-160596; NOAA-TM-NWS-SR-148) Avail: CASI HC A03/MF A01

Air mass modification by vertical motion was discussed. The effects of large scale upward motions on air mass moisture content and lapse rate were considered. A case study of how vertical motions could influence the precipitation probably associated with an approaching short wave trough near Atlanta, Ga. in Dec. 1992 was presented. NTIS

N93-28183# Naval Postgraduate School, Monterey, CA.
RAPID MARINE CYCLOGENESIS FORECAST SENSITIVITY TO HIGH RESOLUTION SEA SURFACE TEMPERATURES DURING ERICA IOP-5 M.S. Thesis
Marcia A. DeCaria Dec. 1992 91 p
(AD-A262117) Avail: CASI HC A05/MF A01

The influence of high resolution sea surface temperatures (SST) on Nested Grid Model (NGM) predictions of rapid marine cyclogenesis is examined. Satellite data provides a gridded SST analysis with a resolution of 50 km. Forecasts using the operational blended SST analysis with a neutral stratification assumed in the calculation of the surface exchange coefficient over the ocean are compared to forecasts using the high resolution SST analysis with a stability dependent surface exchange coefficient. Further comparison is made to NGM forecasts with no surface fluxes. This study covers the Intensive Observation Period (IOP) 5 of the Experiment on Rapidly Intensifying Cyclones over the Atlantic (ERICA). Results show little sensitivity of central pressure and storm position to the high resolution SST's. However, differences in mesoscale features are present, primarily surface fluxes, precipitation, and frontal circulations. DTIC

N93-28192# Naval Postgraduate School, Monterey, CA.
A MARITIME AND CONTINENTAL AEROSOL-CLOUD INTERACTION STUDY FROM ASTEX 1992 M.S. Thesis
Karen M. Ruppe Dec. 1992 114 p
(AD-A262088) Avail: CASI HC A06/MF A02

Variations in marine stratocumulus microphysics during FIRE IFO 1992 are observed and analyzed through the use of NOAA 10/11/12 AVHRR satellite data. Maritime and continental aerosols in clear-air and cloudy regions are characterized by particle size index, optical depth, and low cloud analysis at visible and 3.7 micrometers wavelengths. Use of satellite-detected radiances to resolve aerosol type and distribution prove useful in determining implications of cloud reflectance changes due to modification by aerosol particles. Air masses were clearly defined and showed distinctive signatures in aerosol characteristics and cloud reflectances at 3.7 micrometers wavelengths. Air mass characteristic sources consisted of industrial aerosols out of Europe and desert dust from the Sahara Desert. DTIC

N93-28392# Naval Postgraduate School, Monterey, CA.
EVALUATIONS OF 404 MHz RADAR WIND PROFILER OBSERVATIONS AT OKINAWA DURING TCM-90 M.S. Thesis
Paul H. Dobos Dec. 1992 90 p
(AD-A262701) Avail: CASI HC A05/MF A01

A comparison is made of rawinsonde and radar wind profiler observations recorded in Okinawa during the Tropical Cyclone Motion (TCM-90) field experiment. The rawinsondes were launched from Naha, 18.5 km south-southwest of the wind profiler at Kadena AB. An examination of wind speed, and u- and v-components shows the two wind measuring systems to be in excellent agreement. Wind speed differences are less than 1.5 m/s, and u- and v-component differences are less than 2 m/s. Surface wind data recorded 1.5 km from the radar wind profiler site at Kadena are used to derive statistical relationships between the wind at the five lowest profiler range gates and the surface sustained wind and gusts. The accuracy of regression equations derived from the surface and upper-level data is compared to that of simple wind ratios derived from the same data. The data are also stratified with respect to daytime versus nighttime, and winds having a trajectory from the ocean versus winds with a trajectory from the land. Although the regression equations generally produce a statistically significant smaller prediction error compared to prediction errors from the ratios, the less than 2 m/s improvement in surface wind estimates is not operationally significant. DTIC

48 OCEANOGRAPHY

Includes biological, dynamic, and physical oceanography; and marine resources.

For related information see also *43 Earth Resources and Remote Sensing.*

N93-26943# Woods Hole Oceanographic Inst., MA.
MOORED INSTRUMENT FOR TIME SERIES STUDIES OF PRIMARY PRODUCTION AND OTHER MICROBIAL RATE PROCESSES
C. D. Taylor and K. W. Doherty 20 Jan. 1993 9 p
(Contract DE-FG02-92ER-61426)
(DE93-010148; DOE/ER-61426/1) Avail: CASI HC A02/MF A01

The goal of this project is to build and test a Time Series Submersible Incubation Device (TS-SID) capable of the autonomous in situ measurement of phytoplankton production and other rate processes for a period of up to at least three months. The instrument is conceptually based on a recently constructed Submersible Incubation Device (SID). The TS-SID is to possess the ability to periodically incubate samples in the presence of an appropriate tracer, and to store 94 chemically fixed subsamples for later analysis. The TS-SID has been designed to accurately simulate the natural environment, and to avoid trace metal contamination and physical damage to cells. Devices for biofouling control of internal and external surfaces are to be incorporated into the instrument. After the time series capabilities of the instrument have been successfully evaluated by medium-term coastal time series studies (up to one month), longer-term coastal time series studies (2-3 months) will be conducted to evaluate the biofouling prevention measures that have been used with the instrument. DOE

N93-27635# Naval Postgraduate School, Monterey, CA.
ALONGSHORE SUB-THERMOCLINE CURRENT VARIABILITY IN THE CENTRAL CALIFORNIA CURRENT SYSTEM M.S. Thesis
Michael R. Hicks Dec. 1992 125 p
(AD-A262150) Avail: CASI HC A06/MF A02

Moored current meter observations were made along the central California continental slope from Pt. Piedras Blancas to the Farallon Islands. The study area covered an alongshore distance of approximately 290 km and examined the data from off Pt. Piedras Blancas (P4), Pt. Sur (P2 and P3), Monterey Bay (MB1 and MB2), and the Farallon Islands (D and E). Time and frequency domain analyses were performed on three time segments that included data from combinations of the above mooring locations based on common time periods and depths (350 m - 500 m). Segment 1 revealed a mean poleward flow attributed to the California Undercurrent at all moorings. Segment 2 had a similar mean poleward flow but also exhibited an equatorward reversal at periods between 19.5 and 58.5 days at P2 and MB2 that was less apparent at P3 further offshore and appeared to be coastally trapped. Observed wavelengths were compared with simple wave theory indicating that the observed signal may have resulted from a combination of two theories i.e. a coastally trapped wave. The complex bottom topography between Pt. Sur and the Monterey Bay prohibited more rigorous comparison between theory and the observations. Satellite sea surface temperature imagery during Segment 3 showed an anti-cyclonic meander with a 65 km radius outside of the Monterey Bay. Current and temperature records at P2 and MB2 indicated

that the surface feature's position varied and influenced the currents at depths down to 500 m. Time domain empirical orthogonal functions were calculated for alongshore and across-shore components separately. The first two empirical modes accounted for between 81 percent and 86 percent of the alongshore variance in all segments and were attributed to the mean California Undercurrent influence (mode 1) and to the deviations from the mean state (mode 2). The first two across-shore modes explained between 66 percent and 81 percent of the variance and consistently demonstrated opposing current structures between the Pt. Sur and Monterey Bay moorings, likely due to the Monterey Bay meander influence. DTIC

N93-27637 Royal Netherlands Meteorological Inst., De Bilt. Oceanographic Research Div.

A REAL-TIME WAVE DATA QUALITY CONTROL ALGORITHM

Maria Paula Etala 1991 35 p

(KNMI-TR-139; ISBN-9-03-692009-4; ETN-93-93589) Copyright Avail: Royal Netherlands Meteorological Inst., Postbus 201, 3730 AE De Bilt, Wilhelminalaan 10, Netherlands

A first approach to real-time quality control of wave height and period observations from ships, buoys, and platforms in the North Sea and Norwegian Sea is given. The method is based on the idea of Compressive Quality Control (CQC) for height and temperature rawinsonde data. The principle of the method is not to reject data by the application of successive checks, but to apply at least two more or less independent checks and then evaluate the results by a so called Decision Making Algorithm (DMA). The DMA can either reject, accept, suspect, correct, or rehabilitate the data. It would be very difficult, if not impossible, to obtain for wave data all the benefits from the method when applied to rawinsonde data. Reported values are not computed but observed, so most errors are observational, and those are the most difficult to treat. In addition, the relationships between different variables are less direct for waves, making cross checks highly complicated. Some freedom was taken in the choice of the checks of the present approach, in particular with respect to the hierarchical level required by the CQC. ESA

N93-27684# Texas A&M Univ., College Station. Geochemical and Environmental Group.

CHEMICAL AND BIOLOGICAL VARIABILITY IN THE UPPER WATER COLUMN Final Technical Report

M. C. Kennicutt, II and J. M. Brooks 1993 6 p

(Contract N00014-92-J-1175)

(AD-A262207) Avail: CASI HC A02/MF A01

This program, which has evolved over more than ten years, has had a long-term goal to document and understand chemical and biological variability in the upper water column of the world's oceans. In the final years of the project a major thrust was to develop methods that would more adequately link chemical and biological distributions in the marine environment. To this end an emphasis was placed on developing techniques and measuring photosynthetic pigment distributions as indicators of biological activity in the ocean. These investigations (1) developed and improved the methodologies for measurements of chlorophyll and carotenoid pigments, (2) improved the use of pigments as chemotaxonomic indicators, (3) investigated physical-chemical-biological interactions in frontal areas, (4) increased our understanding of the photo-adaptative strategies of marine phytoplankton, (5) documented unique and novel physiological functions for pigments, and (6) evaluated potential new and more powerful pigment analytical techniques. DTIC

N93-27867# Scripps Institution of Oceanography, La Jolla, CA.

MESOSCALE AND LARGE-SCALE VARIABILITY IN CALIFORNIA CURRENT SYSTEM AND ITS INTERACTION WITH BOTH CALIFORNIA CURRENT AND CALIFORNIA UNDERCURRENT FLOWS Final Report, 8 Jan. 1989 - 31 Jan. 1992

James J. Simpson 9 Mar. 1993 7 p LIMITED REPRODUCIBILITY: More than 20% of this document may be affected by microfishe quality

(Contract N00014-89-J-3181)

(AD-A262195) Avail: CASI HC A02

This project identified and located CTD, XBT, and Advanced Very High Resolution Radiometer (AVHRR) satellite data relevant to understanding oceanic processes which controlled mesoscale variability in the temperature, salinity, and density structure of the California Current System from San Francisco to the tip of Baja California. A software system, the CTD Ocean Rendering and Analysis Laboratory (CORAL), was designed and implemented as part of the project to provide efficient data recovery and analysis capability for the data. Five (5) technical papers were written as part of the project. Titles and abstracts for each are given. DTIC

N93-27924# Scripps Institution of Oceanography, La Jolla, CA.

FILAMENTS IN THE CALIFORNIA CURRENT: EFFECTS UPON PRIMARY PRODUCTION Final Report, 1 Oct. 1988 - 1940 Apr. 1991

Thomas L. Hayward Mar. 1993 5 p

(Contract N00014-89-J-1523)

(AD-A263036) Avail: CASI HC A01/MF A01

This report reviews ONR supported studies conducted as components of the Coastal Transition Zone (CTZ) ARI program. This project organized and collected data on two cruises which were jointly supported by the State of California and participated in data collection on a third cruise. The data were used to investigate how mesoscale physical structure affects the nutrient distribution and primary production in the coastal region. An improved understanding of the physical nature of coastal filaments and their effects upon the nutrient distribution and production was developed, and mesoscale coastal eddies were shown to represent an additional physical structure which can strongly enrich the coastal region. DTIC

N93-28227# Naval Postgraduate School, Monterey, CA.

C-VECTOR DERIVED THREE DIMENSIONAL CIRCULATIONS IN THE FARALLONES NATIONAL MARINE SANCTUARY M.S. Thesis

Simon Konstantinidis Dec. 1992 97 p

(AD-A262885) Avail: CASI HC A05/MF A02

Neglecting the ageostrophic circulation in not very realistic for the ocean circulation in coastal waters and particularly in regions with strong temperature and salinity gradients like the Farallones National Marine Sanctuary. The C-Vector method has been developed to diagnose the three dimensional flow including ageostrophic circulation. This thesis uses the C-Vector concept and data collected from the R/V Point Sur in the area of Farallones National Marine Sanctuary in order to describe and illustrate the three dimensional pseudo-vorticity fields of the ageostrophic circulation and the total circulation (geostrophic and ageostrophic) of the region. DTIC

N93-28244# Hawaii Univ., Honolulu.

INTERNAL GRAVITY WAVES AT ABRUPT TOPOGRAPHY Annual Progress Report

1992 3 p

(Contract N00014-89-J-1315)

(AD-A262286) Avail: CASI HC A01/MF A01

Objectives include description and modeling of the interaction between internal gravity waves and irregular bottom topography, determination of the significance of this interaction, and identification of appropriate theoretical tools to describe the interaction in oceanographically relevant parameter ranges. DTIC

N93-28336# Woods Hole Oceanographic Inst., MA.

ORGANIC GEOCHEMISTRY OF CONTINENTAL MARGIN AND DEEP OCEAN SEDIMENTS

J. K. Whelan, J. M. Hunt, J. M. Seewald, L. B. Eglinton, M. Zawoysky, P. Dickinson, and T. Dickneider Sep. 1992 45 p

(Contract DE-FG02-86ER-13466)

(DE93-011045; DOE/ER-13466/10) Avail: CASI HC A03/MF A01

The objective was to study petroleum formation, migration, and accumulation in marine sediments. Collaboration in Global Basin Research Network (GBRN) showed that the hydrocarbon parameters used in oil exploration are also valuable in understanding sedimentary basin fluid flow processes, crucial to production of drinking water, metal ore deposits, and gas and oil. Two goals are: (1) to run hydrous pyrolysis experiments on immature gas-prone source rocks, in order to evaluate the potential influence of gas evolution on oil migration and subsurface pressurization; and (2) to integrate organic geochemical data from the Louisiana Gulf Coast into GBRN subsurface visualization and computer modeling. Experimental methods (petrography, EPR, thermogravimetric Fourier transform infrared spectroscopy) were also studied. DOE

N93-28377# Naval Research Lab., Bay Saint Louis, MS.
MONTHLY MEAN SEA ICE DATA FROM THE POLAR ICE PREDICTION SYSTEM (PIPS), THE REGIONAL POLAR ICE PREDICTION SYSTEM: BARENTS SEA (RPIPS-B), THE REGIONAL POLAR ICE PREDICTION SYSTEM: GREENLAND SEA (RPIPS-G), AND THE POLAR ICE PREDICTION SYSTEM 2.0 (PIPS 2.0) Final Report
P. G. Posey and R. H. Preller Feb. 1993 126 p
(AD-A262794; NRL/MR/7322-93-7020) Avail: CASI HC A07/MF A02

The Polar Ice Prediction System (PIPS), the Regional Polar Ice Prediction System-Barents Sea (RPIPS-B) and the Regional Polar Ice Prediction System-Greenland Sea (RPIPS-G) are all operational sea ice forecasting systems which have been run daily at the Fleet Numerical Oceanography Center (FNOC) since September 1987, June 1989, and October 1991, respectively. The basis for all three models is the Hibler ice model. The Hibler ice model calculates ice drift, ice thickness, ice concentration (ice edge) and the growth/decay of ice based on both dynamic and thermodynamic effects. The ice models are driven by monthly mean ocean currents and deep ocean heat fluxes derived from the Hibler and Bryan (1987) coupled ice-ocean model. They are also driven by atmospheric forcing from the Navy Operational Global Atmospheric Prediction System (NOGAPS). The Polar Ice Prediction System 2.0 (PIPS2.0), a new version of PIPS, is presently undergoing the final testing phase. PIPS2.0 has been modified into a spherical coordinate version of PIPS and coupled with an ocean model. Similar to the operational models, daily atmospheric NOGAPS forcing is used to produce a 24-hour forecast. DTIC

N93-28396# Coastal Engineering Research Center, Vicksburg, MS.
WAVE INFORMATION STUDIES OF US COASTLINES: VERIFICATION OF PACIFIC OCEAN DEEPWATER HINDCAST WAVE INFORMATION Final Report
Jon M. Hubertz, Barbara A. Tracy, Jane B. Payne, and Alan Cialone Dec. 1992 71 p
(AD-A262714; CERC-WIS-29) Avail: CASI HC A04/MF A01

The Wave Information Study (WIS) for the Northern Pacific Ocean (WIS Reports 14 and 16) provides a wave climate for the US shorelines of the Northern Pacific based on simulation of 20 years of weather data from the period 1956-1975. During these years few wave data exist with which to evaluate the adequacy of the total hindcast procedure, which includes derivation of pressure charts, translation of these into wind estimates, and then calculation of wave conditions. In 1991, the Coastal Engineering Research Center conducted a 1-year hindcast of the Northern Pacific Ocean for the year 1988 and evaluated the model results against extensive wind and wave measurements now available in order to provide guidance on the quality of the previous hindcast work. This report provides a summary of that hindcast and guidance on the use of the earlier WIS study. DTIC

N93-28397# Scripps Institution of Oceanography, La Jolla, CA. Center for Coastal Studies.
OBSERVATIONS OF TURBULENCE IN THE SURF ZONE Final Report, 1 Oct. 1988 - 30 Sep. 1992
Ron George, Reinhard E. Flick, and R. T. Guza Mar. 1993 36 p
(Contract N00014-89-J-1059)
(AD-A262718; SIO-REF-93-1) Avail: CASI HC A03/MF A01

The turbulence generated by waves breaking on a natural beach is examined using hotfilm anemometer data. Turbulence intensity is estimated from the dissipation rate and an appropriate length scale (a fraction of the water depth). The dissipation rates are determined from wavenumber spectra found by applying Taylor's hypothesis to frequency spectra of short (1/8s) hotfilm time series. The resulting Froude-scaled turbulence intensities are relatively uniform throughout the water column and are similar in vertical structure but lower in magnitude than in existing laboratory studies. The magnitudes of the turbulence intensity observed in both the field and laboratory are consistent with an existing macroscopic model of bore dissipation in the surf zone. Scaling by this bore model relates turbulence intensity levels of monochromatic waves in small-scale laboratory experiments to random waves in the natural surf zone. DTIC

51 LIFE SCIENCES (GENERAL)

N93-26700*# General Electric Co., Houston, TX. Government Services.
SPACE STATION FREEDOM BIOMEDICAL MONITORING AND COUNTERMEASURES: BIOMEDICAL FACILITY HARDWARE CATALOG
15 Jun. 1990 183 p Sponsored by NASA. Lyndon B. Johnson Space Center
(NASA-CR-193156; NAS 1.26:193156; LS-35001) Avail: CASI HC A09/MF A02

This hardware catalog covers that hardware proposed under the Biomedical Monitoring and Countermeasures Development Program supported by the Johnson Space Center. The hardware items are listed separately by item, and are in alphabetical order. Each hardware item specification consists of four pages. The first page describes background information with an illustration, definition and a history/design status. The second page identifies the general specifications, performance, rack interface requirements, problems, issues, concerns, physical description, and functional description. The level of hardware design reliability is also identified under the maintainability and reliability category. The third page specifies the mechanical design guidelines and assumptions. Described are the material types and weights, modules, and construction methods. Also described is an estimation of percentage of construction which utilizes a particular method, and the percentage of required new mechanical design is documented. The fourth page analyzes the electronics, the scope of design effort, and the software requirements. Electronics are described by percentages of component types and new design. The design effort, as well as, the software requirements are identified and categorized. Author

N93-27085*# Case Western Reserve Univ., Cleveland, OH.
SHAPE OPTIMIZATION OF TIBIAL PROSTHESIS COMPONENTS
D. A. Saravanos, P. J. Mraz, and D. T. Davy Apr. 1993 33 p
(Grant NAG3-1027; RTOP 141-20-0F)
(NASA-CR-191123; E-7815; NAS 1.26:191123) Avail: CASI HC A03/MF A01

NASA technology and optimal design methodologies originally developed for the optimization of composite structures (engine blades) are adapted and applied to the optimization of orthopaedic knee implants. A method is developed enabling the shape tailoring of the tibial components of a total knee replacement implant for optimal interaction within the environment of the tibia. The shape of the implant components are optimized such that the stresses in the bone are favorably controlled to minimize bone degradation, to improve the mechanical integrity of the implant/interface/bone system, and to prevent failures of the implant components. A pilot tailoring system is developed and the feasibility of the concept is demonstrated and evaluated. The methodology and evolution of the existing aerospace technology from which this pilot optimization code was developed is also presented and discussed. Both symmetric and unsymmetric in-plane loading conditions are investigated. The results of the optimization process indicate a trend toward wider and tapered posts as well as thicker backing trays. Unique component geometries were obtained for the different load cases. Author

N93-27122*# Umpqua Research Co., Myrtle Creek, OR. Aerospace Div.
REGENERABLE BIOCIDE DELIVERY UNIT, VOLUME 1 Final Report
James E. Atwater and Richard R. Wheeler, Jr. Sep. 1992 310 p
(Contract NAS9-18361)
(NASA-CR-185701; NAS 1.26:185701; URC-80356) Avail: CASI HC A14/MF A03

The Microbial Check Valve (MCV), which is currently used aboard the Shuttle Orbiter for disinfection of the potable water supply, is an expendable flow-through canister containing iodinated ion exchange resin. Means for extension of MCV life are desirable to avoid resupply penalties. The Phase 1 Regenerable Biocide Delivery Unit program demonstrated the feasibility of regenerating an MCV in situ, using a strong aqueous elemental iodine solution resulting from diversion of the MCV influent to a packed bed containing iodine crystals. In small column tests, eight manual regenerations of an MCV resin were accomplished. The term Regenerative Microbial Check Valve (RMCV) was adopted describing this new technology. The Phase 2 program resulted in the development of a full scale and fully autonomous prototype RMCV, capable of maintaining residual I(sub 2) levels

between 2.0 - 4.0 mg/L for prolonged periods. During six months of testing at the Space Station baseline flow rate of 120 cm(sup 3)/min, the prototype RMCV underwent nine regenerations. RMCV life cycle tests, using a variety of influent streams, were conducted over an eighteen month period to determine the useful lives of MCV's incorporating this new technology and to determine ultimate failure mechanisms. MCV life extensions of 130 fold were demonstrated, limited only by the Phase 2 performance period. Based upon this work, it is certain that RMCV units can be developed to provide unattended biocide addition for the thirty year life of Space Station Freedom, or for other longer duration applications such as a Lunar Base or Mars mission. RMCV technology was also demonstrated capable of delivering, on demand, a concentrated aqueous I(sub 2) solution for potential use as a disinfectant during transient episodes of microbial surface contamination, for the control of biofilm formation, or as a preventative measure in systems which are particularly susceptible to the growth of microorganisms. Author (revised)

N93-27152# Civil Aeromedical Inst., Oklahoma City, OK.
VARIATIONS OF TIME-TO-INCAPACITATION AND CARBOXYHEMOGLOBIN VALUES IN RATS EXPOSED TO TWO CARBON MONOXIDE CONCENTRATIONS Final Report
Donald C. Sanders, Boyd R. Endecott, Roxane M. Ritter, and Arvind K. Chaturvedi May 1993 18 p
(DOT/FAA/AM-93/7) Avail: CASI HC A03/MF A01

It has been suggested that passenger protective breathing equipment protect aircraft passengers from smoke for 5 min during an evacuation phase and for 35 min during an in-flight-plus-evacuation phase. Carbon monoxide (CO) is one of the most abundant smoke components and is the major threat in most fire atmospheres. Time-to-incapacitation (t(sub i)) is an end-point related to escape from a fire, and variations in t(sub i) measurements at specific CO concentrations have not been statistically documented. Therefore, variance in t(sub i) at two CO concentrations that produce 5- and 35-min t(sub i) in rats were determined; blood carboxyhemoglobin (COHb) saturation at t(sub i) was measured. Fifty male Sprague-Dawley rats were individually exposed to each CO concentration in a chamber equipped with a rotating cage, and t(sub i) was recorded as the time from insertion of the animal into the cage until it could no longer walk. In another set of experiments, blood COHb saturation was determined in rats exposed to these CO concentrations at stepwise intervals less than t(sub i). At incapacitation and at the end of each exposure interval, rats were quickly removed from the cage and killed for blood collection and COHb quantization. Values (mean +/- SD) for measured parameters were: for the 5-min t(sub i) study, CO = 5706 +/- 178 ppm, t(sub i) = 5.0 +/- 0.36 min, and COHb = 80.8 +/- 1.3%; for the 35-min t(sub i) study, CO = 1902 +/- 33 ppm, t(sub i) = 34.8 +/- 6.8 min, and COHb = 71.2 +/- 1.0%. COHb levels tended to plateau prior to incapacitation. Coefficients of variation for t(sub i) were 7.2% and 19.5% for the 5- and 35-min study, respectively. The significant difference in the two COHb levels and the approach of COHb to a maximal level before incapacitation suggest that blood COHb saturation levels may not necessarily be indicative of the onset of incapacitation. Author (revised)

N93-27360*# Umpqua Research Co., Myrtle Creek, OR. Aerospace Div.
REGENERABLE BIOCIDE DELIVERY UNIT, VOLUME 2 Final Report
James E. Atwater and Richard R. Wheeler, Jr. Sep. 1992 98 p
(Contract NAS9-18361)
(NASA-CR-185701-Vol-2; NAS 1.26:185701-Vol-2; URC-80356) Avail: CASI HC A05/MF A02

Source code for programs dealing with the following topics are presented: (1) life cycle test stand-parametric test stand control (in BASIC); (2) simultaneous aqueous iodine equilibria-true equilibrium (in C); (3) simultaneous aqueous iodine equilibria-pseudo-equilibrium (in C); (4) pseudo-(fast)-equilibrium with iodide initially present (in C); (5) solution of simultaneous iodine rate expressions (Mathematica); (6) 2nd order kinetics of I2-formic acid in humidity condensate (Mathematica); (7) prototype RMCV onboard microcontroller (CAMBASIC); (8) prototype RAM data dump to PC (in BASIC); and (9) prototype real time data transfer to PC (in BASIC). CASI

N93-27989# National Defence Research Establishment, Umea (Sweden). Microbiology Div.
INTRACELLULAR TARGETING OF THE YERSINIA YopE CYTOTOXIN IN MAMMALIAN CELLS INDUCES ACTIN MICROFILAMENT DISRUPTION
Roland Rosqvist, Aake Forsberg, and Hans Wolf-Watz (Umea Univ., Sweden.) Dec. 1991 8 p Repr. from Infection and Immunity, v. 59, no. 12, Dec. 1991 p 4562-4569 Sponsored in part by Swedish Board of Technical Development
(Grants SMRC-07490-5A; SNSRC-4426-3011)
(FOA-B-40420-4.4; ETN-93-93765) Copyright Avail: CASI HC A02/MF A01

An experiment which showed that isolated Yop (Yersinia outer membrane proteins) present in Pathogenic Yersinia spp. that encode a number of essential virulence determinants, cause cytoxic effects in vitro if the proteins are introduced intracellulary into the eukaryotic cell, is described. Isolated Yop proteins of Yersinia pseudotuberculosis were found to disrupt the microfilament structure only when microinjected intracellulary into the host cell. In particular, YopE was demonstrated to be directly involved in the cytotoxication, whereas YopD seems to have a critical role in translocating the YopE protein through the host cell membrane. These results elucidate the requirement for at least some of the Yop proteins to leave the pathogen during infection. ESA

N93-28199# National Defence Research Establishment, Umea (Sweden). Cell and Microbiology Dept.
PLASMID ENCODED VIRULENCE OF YERSINIA
H. Wolf-Watz, A. Forsberg, R. Rosqvist, I. Boelin, K. Erickson, L. Norlander, M. Rimpilaeinen, T. Bergman, and S. Haakansson 1991 5 p Prepared in cooperation with Umea Univ., Sweden
(FOA-B-40419-4.4; ETN-93-93764) Avail: CASI HC A01/MF A01

The expression of virulence plasmid encoded virulence determinants is discussed and it is concluded that the three virulent species of Yersinia contain homologous virulence plasmids that encode a number of temperature inducible Ca(2+) regulated proteins (Yops (Yersinia outer membrane proteins)). Mapping and regulation of Yop genes is discussed and it is concluded that the expression of the Yops is regulated at the level of transcription involving negative as well as positive control elements encoded by the Ca(2+) region. Work which resulted in the conclusion that YopH and YopE are essential virulence determinants which obstruct the primary host defense by preventing phagocytosis is discussed. ESA

N93-28200# National Defence Research Establishment, Umea (Sweden). Microbiology Div.
CHARACTERIZATION AND CLASSIFICATION OF STRAINS OF FRANCISELLA TULARENSIS ISOLATED IN THE CENTRAL ASIAN FOCUS OF THE SOVIET UNION AND IN JAPAN
G. Sandstroem, A. Sjoestedt, M. Forsman, N. V. Pavlovich (Rostov State Univ., Rostov-on-Don, USSR.), and B. N. Mishankin (Rostov State Univ., Rostov-on-Don, USSR.) Jan. 1992 4 p Repr. from Journal of Clinical Microbiology, v. 30, no. 1, Jan. 1992 p 172-175
(FOA-B-40421-4.4; ETN-93-93766) Copyright Avail: CASI HC A01/MF A01

An experiment which suggests that classification of strains of Francisella on the basis of 16S rRNA analysis may be preferable to classification on the basis of biochemical analysis is described and results and conclusions given. The two subspecies of Francisella tularensis, F. tularensis subsp. tularensis (type A) and F. tularensis subsp. palaearctica (type B), differ from each other in biochemistry and virulence. Strains of type A are believed to be confined to North America, whereas strains of type B occur in Europe, in Asia, and in North America. Moreover, the existence of two other subspecies, designated F. tularensis subsp. mediaasiatica and F. tularensis subsp. palaearctica japonica, has been suggested for strains of F. tularensis isolated in the central Asian focus of the Soviet Union and in Japan, respectively. Strains biochemically classified as F. tularensis subsp. mediaasiatica or F. tularensis subsp. palaeartica japonica were investigated by hybridization with probes specific to 16S rRNAs of the two main species. Furthermore, the virulence and biochemical characteristics of the strains were compared with those of strains belonging to type A and type B. It was found that 16S rRNAs of F. tularensis subsp. mediaasiatica and F. tularensis subsp. palaeartica japonica hybridize with the probe specifc to a geniotype proposed, genotype A (type A), which shows that strains

genetically related to this subspecies are found outside North America. However, the central Asian strains differed from type A and type B strains when investigated by fermentation of glucose. It was concluded that the results of the biochemical tests could not be unambiguously used for differentiation of strains into F. tularensis subsp. palaearctica or F. tularensis subsp. tularensis. ESA

N93-28212# National Defence Research Establishment, Umea (Sweden). Cell Biology and Microbiology Dept.
USE OF RNA HYBRIDIZATION IN THE DIAGNOSIS OF A CASE OF ULCEROGLANDULAR TULAREMIA
M. Forsman, K. Kuoppa, A. Sjoestedt, and A. Taernvik (Umea Univ., Sweden.) 1990 2 p Repr. from Eur. J. Clin. Microbiol. Infect Dis., v. 9, 1990 p 784-785
(FOA-B-40422-4.4; ETN-93-93767) Avail: CASI HC A01/MF A01

A case study in which 16S ribosomal RNA of Francisella tularensis were successfully used in the diagnosis of a wound specimen from a patient with ulceroglandular tularemia is presented. A genus specific probe was constructed from the 16S ribosomal RNA which was used in the diagnosis. It was shown that the hybridization technique is much more rapid than culture procedures and carries a lower risk of laboratory infection. As illustrated, the hybridization procedure is also useful for determination of the Francisella tularensis biovar. ESA

N93-28415*# Pennsylvania State Univ., University Park.
ELECTROPHORETIC SEPARATION OF CELLS AND PARTICLES FROM RAT PITUITARY AND RAT SPLEEN Final Report, period ending 31 Mar. 1993
Wesley C. Hymer 31 Mar. 1993 81 p
(Grant NAG8-807)
(NASA-CR-193073; NAS 1.26:193073) Avail: CASI HC A05/MF A01

There are 3 parts to the IML-2 TX-101 experiment. Part 1 is a pituitary cell culture experiment. Part 2 is a pituitary cell separation experiment using the Japanese free flow electrophoresis unit (FFEU). Part 3 is a pituitary secretory granule separation experiment using the FFEU. The objectives of this three part experiment are: (1) to determine the kinetics of production of biologically active growth hormone (GH) and prolactin (PRL) in rat pituitary GH and PRL cells in microgravity (micro-g); (2) to investigate three mechanisms by which a micro-g-induced lesion in hormone production may occur; and (3) to determine the quality of separations of pituitary cells and organelles by continuous flow electrophoresis (CFE) in micro-g under conditions where buoyancy-induced convection is eliminated. Author (revised)

52 AEROSPACE MEDICINE

Includes physiological factors; biological effects of radiation; and effects of weightlessness on man and animals.

N93-26945* National Aeronautics and Space Administration, Washington, DC.
AEROSPACE MEDICINE AND BIOLOGY: A CONTINUING BIBLIOGRAPHY WITH INDEXES (SUPPLEMENT 373)
Mar. 1993 74 p
(NASA-SP-7011(373); NAS 1.21:7011(373)) Avail: CASI HC A04/MF A01

This bibliography lists 206 reports, articles and other documents introduced into the NASA Scientific and Technical Information System during Feb. 1993. Subject coverage includes: aerospace medicine and physiology, pharmacology, toxicology, environmental effect, life support systems and man/system technology, protective clothing, exobiology and extraterrestrial life, planetary biology, and flight crew behavior and performance. Author

N93-27102*# Brown Univ., Providence, RI. Dept. of Pathology and Lab. Medicine.
MECHANICAL STIMULATION OF SKELETAL MUSCLE INCREASES PROSTAGLANDIN F2(ALPHA) SYNTHESIS AND CYCLOOXYGENASE ACTIVITY BY A PERTUSSIS TOXIN SENSITIVE MECHANISM
Herman H. Vandenburgh, Janet Shansky, Rosa Solerssi, and Joseph Chromiak [1992] 48 p
(Grant NAG2-414)
(NASA-CR-193041; NAS 1.26:193041) Avail: CASI HC A03/MF A01

Repetitive mechanical stimulation of differentiated skeletal muscle in tissue culture increases the production of prostaglandin F(sub 2(alpha)), an anabolic stimulator of myofiber growth. Within 4 h of initiating mechanical activity, the activity of cyclooxygenase, a regulatory enzyme in prostaglandin synthesis, was increased 82% (P is less than .005), and this increase was maintained for at least 24 h. Kinetic analysis of the stretch-activated cyclooxygenase indicated a two to three-fold decrease in the enzyme's K(sub m) with no change in V(sub max). The stretch-induced increase in enzymatic activity was not inhibited by cycloheximide, was independent of cellular electrical activity (tetrodotoxin-insensitive), but was prevented by the G protein inhibitor pertussis toxin. Pertussis toxin also inhibited the stretch-induced increases in PGF(sub 2(alpha)) production, and cell growth. It is concluded that stretch of skeletal muscle increases the synthesis of the anabolic modulator PGF(sub 2(alpha)) by a G protein-dependent process which involves activation of cyclooxygenase by a posttranslational mechanism. Author (revised)

N93-27113*# Brown Univ., Providence, RI. Dept. of Pathology.
GROWTH FACTOR INVOLVEMENT IN TENSION-INDUCED SKELETAL MUSCLE GROWTH Semiannual Report, 1 Nov. 1992 - 30 Apr. 1993
Herman H. Vandenburgh 30 Apr. 1993 8 p
(Grant NAG2-414)
(NASA-CR-193023; NAS 1.26:193023) Avail: CASI HC A02/MF A01

Long-term manned space travel will require a better understanding of skeletal muscle atrophy which results from microgravity. Astronaut strength and dexterity must be maintained for normal mission operations and for emergency situations. Although exercise in space slows the rate of muscle loss, it does not prevent it. A biochemical understanding of how gravity/tension/exercise help to maintain muscle size by altering protein synthesis and/or degradation rate should ultimately allow pharmacological intervention to prevent muscle atrophy in microgravity. The overall objective is to examine some of the basic biochemical processes involved in tension-induced muscle growth. With an experimental in vitro system, the role of exogenous and endogenous muscle growth factors in mechanically stimulated muscle growth are examined. Differentiated avian skeletal myofibers can be 'exercised' in tissue culture using a newly developed dynamic mechanical cell stimulator device which simulates different muscle activity patterns. Patterns of mechanical activity which significantly affect muscle growth and metabolic characteristics were found. Both exogenous and endogenous growth factors are essential for tension-induced muscle growth. Exogenous growth factors found in serum, such as insulin, insulin-like growth factors, and steroids, are important regulators of muscle protein turnover rates and mechanically-induced muscle growth. Endogenous growth factors are synthesized and released into the culture medium when muscle cells are mechanically stimulated. At least one family of mechanically induced endogenous factors, the prostaglandins, help to regulate the rates of protein turnover in muscle cells. Endogenously synthesized IGF-1 is another. The interaction of muscle mechanical activity and these growth factors in the regulation of muscle protein turnover rates with our in vitro model system is studied. Author

N93-27158# Civil Aeromedical Inst., Oklahoma City, OK. Office of Aviation Medicine.
VARIATIONS IN TIME-TO-INCAPACITATION AND BLOOD CYNANIDE VALUES FOR RATS EXPOSED TO TWO HYDROGEN CYANIDE GAS CONCENTRATIONS Final Report
Arvind K. Chaturvedi, Boyd R. Endecott, Roxane M. Ritter, and Donald C. Sanders May 1993 20 p
(DOT/FAA/AM-93-8) Avail: CASI HC A03/MF A01

It has been suggested that protective breathing devices protect aircraft passengers from combustion products for 5 min during evacuation and for 35 min during in-flight-plus-evacuation. Hydrogen cyanide (HCN), a combustion gas, produces incapacitation at relatively low concentrations, and time-to-incapacitation (t(sub i) is an applicable index for predicting escape from a fire. Variations in t(sub i) and blood cyanide (CN-) at specific HCN gas exposure concentrations have not been evaluated. Therefore, t(sub i) and blood CN- at t(sub i) for two HCN concentrations that produce 5- and 35-min t(sub i) were determined in male Sprague-Dawley rats. Blood CN- levels as a function of HCN exposure time were measured. Animals were individually exposed to HCN gas in a chamber equipped

with a rotating cage, and t(sub i) was recorded as the time from insertion of the animal into the cage until it could no longer walk. At incapacitation and at selected intervals prior to t(sub i), rats were quickly removed from the cage and killed for blood collection and CN- quantitation. Chamber HCN concentrations were monitored during the exposures. For the 5-min test (mean plus or minus SD; n = 50), HCN gas = 184 plus or minus 10.0 ppm, t(sub i) = 5.1 plus or minus 0.8 min, and blood CN- = 2.3 plus or minus 0.5 micro-g/mL; for the 35-min test, HCN gas = 64 plus or minus 6.1 ppm, t(sub i) = 31.1 plus or minus 11.2 min, and blood CN- = 4.2 plus or minus 1.3 micro-g/mL. Blood CN- levels increased as a function of HCN exposure time, but the blood CN- level at the 5-min t(sub i) was half of the 35-min blood CN- level; the HCN gas uptake rate at 184 ppm was about 3 times that at 64 ppm. These findings suggest that the blood CN- level at incapacitation may vary substantially, depending upon the HCN exposure concentration; an equation is proposed for predicting blood CN- levels in rats. Author (revised)

N93-27409# Veterans Administration Hospital, San Francisco, CA.
SECONDARY INJURY FACTORS AND PREVENTATIVE TREATMENT Final Report, 15 Jul. 1987 - 14 Jul. 1991
A. I. Faden May 1992 170 p
(Grant DHHS-R59-CCR-902269)
(PB93-176014) Avail: CASI HC A08/MF A02

The project included three independent, parallel studies: two involving experimental animals (head injury, spinal cord injury) and one involving humans (head injury). The underlying hypotheses for this work were that: (1) secondary, delayed injury resulting from actions of endogenous, autodestructive factors represents a significant contributing factor to the neurological disability that follows brain or spinal cord trauma; (2) that endogenous opioids (particularly dynorphin) and excitatory amino acids represent major classes of autodestructive factors; (3) that opioid receptor antagonists, or N-methyl-D-aspartate (NMDA) receptor antagonists administered within the first hours of trauma, improve neurological outcome; (4) that kappa-selective opioid antagonists are more effective than non-selective antagonists in treating central nervous system trauma; and (5) that magnetic resonance spectroscopy (MRS) may enhance prognostic abilities in CNS trauma by monitoring metabolic changes and the response to treatment. NTIS

N93-27654# California Univ., Irvine. Center for Neurobiology of Learning and Memory.
ANALYSIS OF NEURAL SYSTEMS INVOLVED IN MODULATION OF MEMORY STORAGE Final Report, 1 Jan. 1990 - 31 Dec. 1992
James L. McGaugh 1 Feb. 1993 6 p
(Contract N00014-90-J-1626)
(AD-A262418) Avail: CASI HC A02/MF A01

The aims of this research project were to investigate the involvement of opiate and GABAergic systems, in different brain regions, in regulating the storage of memory for different types of tasks. The proposed experiments were based on previous findings providing extensive evidence that memory storage is influenced by treatments affecting neuromodulatory systems in the amygdala as well as preliminary evidence suggesting the possibility that such influences might be limited to restricted domains (or forms) of learning and memory. The view that GABAergic and opiate drugs act by influencing memory storage is supported by previous, as well as recent evidence that the drugs do not induce state-dependency. That is, the effects on retention performance do not depend upon a congruence between drug states at the time of training (or shortly after training) and retention testing. The research supported by this grant has provided additional evidence that memory storage is influenced by opiate and GABAergic influences. Within the range of tasks examined, the effects did not depend upon the forms of learning and memory examined. Both the amygdala and septum appear to be involved in regulating GABAergic influences on memory and the effects appear to be mediated through cholinergic influences. DTIC

N93-27923# Army Aeromedical Research Lab., Fort Rucker, AL.
THE USE OF ELECTROPHYSIOLOGICAL AND COGNITIVE VARIABLES IN THE ASSESSMENT OF DEGRADATION DURING PERIODS OF SUSTAINED WAKEFULNESS Final Report
Carlos A. Comperatore, John A. Caldwell, Jr., Robert L. Stephens, Jim A. Chiaramonte, and Jacquelyn Y. Pearson Dec. 1992 64 p
(DA Proj. 3M1-62787-A-897)
(AD-A263033; USAARL-93-5) Avail: CASI HC A04/MF A01

Army aviation personnel often encounter work schedules which require the transition from daytime to nighttime duty hours without the benefit of an adaptation period. Rotations from daytime and nighttime duty hours, particularly those that occur within a 24-hour period, usually result in loss of sleep, fatigue, and cognitive degradation. Strategies in the scheduling of sleep, meals, work, and exercise are currently under study with the purpose of identifying patterns that assist in the physiological adaptation to nighttime duty hours. These coping strategies are composed of countermeasures designed to prevent the sleep loss and chronic fatigue usually associated with rapid transitions from daytime to nighttime duty hours. The study of shiftwork coping strategies requires the empirical characterization of effective countermeasures which prevent chronic fatigue and preserve normal cognitive function. In the laboratory, the study of variables such as alertness, sensory processing, reaction time, and cognitive processing assessment approach requires the use of multidisciplinary test batteries that not only challenge cognitive processes, but also document the functional status of brain regions associated with sensory processing and alertness. The aim of this study was to evaluate the usefulness of a test battery designed to characterize the state of alertness and cognitive ability of subjects involved in postponing sleep for approximately 60 consecutive hours. DTIC

N93-28122# Los Alamos National Lab., NM. Life Sciences Div.
EVALUATION OF NO(x)-INDUCED TOXICITY Final Report, 1 Jul. 1985 - 30 Sep. 1992
Bruce E. Lehnert 31 Dec. 1992 229 p
(DA Proj. 3M1-61102-BS-15)
(AD-A261034) Avail: CASI HC A11/MF A03

Investigations conducted from FY85-FY93 in the project entitled evaluation of NO(x)-induced toxicity are summarized. During the course of the studies, investigations were undertaken to address numerous objectives. Specific information provided is formatted in the context of the objective(s) it concerns, a brief summary of accomplishments and findings that are detailed in the section, and citations of reports and publications that have emanated in total or in part from research performed during the accomplishment objective(s). Each section begins with its own Introduction, which is then followed by a Materials and Methods section, a Results section and a Summary or Discussion. Author (revised)

N93-28293# Ohio State Univ., Columbus. Coll. of Pharmacy.
13 C NMR SPECTRA OF ALLOSTERIC EFFECTORS OF HEMOGLOBIN
Stanislaw Ostrowski, Thomas G. Burke, and Waldemar Priebe 1993 6 p Prepared in cooperation with Texas Univ., Houston
(Contract N00014-90-J-1648)
(AD-A262979) Avail: CASI HC A02/MF A01

In the last three years, many papers dealing with the preparation and biological activity of compounds that act as allosteric effectors of hemoglobin have been published. Among the numerous moieties, some urea derivatives were found to be very effective in reducing oxygen affinity of hemoglobin. The structures of most of the compounds were confirmed by H-1 NMR spectra; however, to our knowledge, C-13 NMR spectra have not been published for any of these allosteric modifiers of hemoglobin. We prepared in this series over 30 new urea and thiourea derivatives with the intent of investigating their biological activity. An analysis of C-13 NMR spectra revealed high regularity in the chemical shifts of the similar fragments of the structures and revealed signal deviations among structures having different substituents in the aromatic rings. DTIC

N93-28306# Federal Aviation Administration, Washington, DC. Office of Aviation Medicine.
INDEX OF INTERNATIONAL PUBLICATIONS IN AEROSPACE MEDICINE Final Report
Melchor J. Antunano Feb. 1993 26 p
(AD-A262908; DOT/FAA/AM-93/3) Avail: CASI HC A03/MF A01

The Index of International Publications in Aerospace Medicine is a comprehensive listing of international publications in clinical aerospace medicine, operational aerospace medicine, aerospace physiology, environmental medicine/physiology, diving medicine/physiology, aerospace human factors, as well as other important topics directly- or indirectly-related to aerospace medicine. The Index is divided into six major sections: (1)

Open Publications in General Aerospace Medicine; (2) Government Publications in General Aerospace Medicine; (3) Publications in other Topics related to Aerospace Medicine; (4) Proceedings from Scientific Meetings, Conferences, and Symposiums in Aerospace Medicine; (5) Journals, Newsletters, and Bulletins in Aerospace Medicine; and (6) Online Computerized Databases containing Bibliographic Information in Aerospace Medicine and Related Disciplines. DTIC

53 BEHAVIORAL SCIENCES

Includes psychological factors; individual and group behavior; crew training and evaluation; and psychiatric research.

N93-27103# Advanced Aviation Concepts, Jupiter, FL.
HOW EXPERT PILOTS THINK: COGNITIVE PROCESSES IN EXPERT DECISION MAKING Final Report
Richard J. Adams Feb. 1993 82 p Sponsored by DOT/FAA Research and Development Service, Washington, DC
(Contract DTFA01-90-C-00042)
(DOT/FAA/RD-93/9) Avail: CASI HC A05/MF A01

This report is the second in the investigation of the role of expert cognitive processes in Aeronautical Decision Making (ADM). The first report defined the differences between expert and novice decision makers and correlated the development of expert pilot cognitive processes with training and experience. This volume continues the research into the understanding of how pilots think by examining human information processing and expert problem solving characteristics. From this analysis, the mental attributes critical to developing expert decision making are explained, and three basic limits on decision making are identified. These are attention span, short term memory, and long term memory. Next, the analysis examines the development of Expert Decision Making (EDM) from the comparison of how novices and experts perceive, store, organize and use their knowledge. This analysis shows that high levels of competence result from the interaction between knowledge organization and processing abilities. Experts are found to possess the abilities of rapid access to, and efficient utilization of a highly organized body of conceptual and procedural knowledge. That is, an elaborately structured set of associated concepts, procedures and events--based upon many years of study, training, and experience in a aviation. The use of this knowledge base is described in terms of the characteristics of EDM related to perception, attention, memory, creativity, and superior situational awareness. Since the speed and accuracy of expert cognitive processes make them take on the characteristics of insight or intuition, the role of intuition in decision making is the next analytical part of the investigation. Intuition is defined and the properties of intuition relevant to EDM delineated. Finally, the report concludes by presenting alternative EDM training opportunities including: training to enhance memory, computer based training tools, and promising methods for testing pilots which will also provide training and the opportunity to learn the cognitive skills of experts without spending all of the learning time in actual flight. Author

N93-28128*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
METHOD OF ENCOURAGING ATTENTION BY CORRELATING VIDEO GAME DIFFICULTY WITH ATTENTION LEVEL Patent Application
Alan T. Pope, inventor (to NASA) and Edward H. Bogart, inventor (to NASA) (Lockheed Engineering and Sciences Co., Hampton, VA.) 8 Mar. 1993 37 p
(NASA-Case-LAR-15022-1; NAS 1.71:LAR-15022-1; US-Patent-Appl-SN-029808) Avail: CASI HC A03/MF A01

A method of encouraging attention in persons such as those suffering from Attention Deficit Disorder is provided by correlating the level of difficulty of a video game with the level of attention in a subject. A conventional video game comprises a video display which depicts objects for interaction with a player and a difficulty adjuster which increases the difficulty level, e.g., action speed and/or evasiveness of the depicted object, in a predetermined manner. The electrical activity of the brain is measured at selected sites to determine levels of awareness, e.g., activity in the beta, theta, and alpha states. A value is generated based on this measured electrical signal which is indicative of the level of awareness. The difficulty level of the game is increased as the awareness level value decreases and is decreased as this awareness level value increases. NASA

N93-28307# Aerospace Medical Research Labs., Wright-Patterson AFB, OH.
THEORY OF SIGNAL DETECTION AND ITS APPLICATION TO VISUAL TARGET ACQUISITION: A REVIEW OF THE LITERATURE Final Report, Oct. 1991 - May 1992
Denise L. Wilson May 1992 56 p
(AD-A262920; AL-TR-1992-0083) Avail: CASI HC A04/MF A01

An operator's performance in a target acquisition task may be influenced by variables which are not directly associated with the target and imagery but are associated with the decision rule employed by the operator. The separation of factors that influence the operator's decision criterion from those that influence sensitivity is a major contribution of the psychophysical application of the Theory of Signal Detection (TSD). This report focuses on practical application of TSD to the problem of operator acquisition of targets in sensor imagery which ray, or may not, have been prescreened by an automatic target recognizer. The foundation of TSD in Statistical Decision Theory is discussed as well as specific methods for applying TSD to laboratory evaluation of the target acquisition task. A brief review is presented of target acquisition studies in which TSD was utilized. DTIC

54 MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT

Includes human engineering; biotechnology; and space suits and protective clothing.

For related information see also *16 Space Transportation.*

N93-27100*# Orbital Technologies Corp., Madison, WI.
1991 NASA LIFE SUPPORT SYSTEMS ANALYSIS WORKSHOP Final Report, 1991
Peggy L. Evanich (National Aeronautics and Space Administration, Washington, DC.), Thomas M. Crabb, and Charles F. Gartrell (General Research Corp., Vienna, VA.) 1 Mar. 1992 112 p Workshop held in Milwaukee, WI, 24-27 Jun. 1991
(Contract NASw-4470)
(NASA-CR-4466; NAS 1.26:4466) Avail: CASI HC A06/MF A02

The 1991 Life Support Systems Analysis Workshop was sponsored by NASA Headquarters' Office of Aeronautics and Space Technology (OAST) to foster communication among NASA, industrial, and academic specialists, and to integrate their inputs and disseminate information to them. The overall objective of systems analysis within the Life Support Technology Program of OAST is to identify, guide the development of, and verify designs which will increase the performance of the life support systems on component, subsystem, and system levels for future human space missions. The specific goals of this workshop were to report on the status of systems analysis capabilities, to integrate the chemical processing industry technologies, and to integrate recommendations for future technology developments related to systems analysis for life support systems. The workshop included technical presentations, discussions, and interactive planning, with time allocated for discussion of both technology status and time-phased technology development recommendations. Key personnel from NASA, industry, and academia delivered inputs and presentations on the status and priorities of current and future systems analysis methods and requirements. Author

N93-27101*# Orbital Technologies Corp., Madison, WI.
1992 NASA LIFE SUPPORT SYSTEMS ANALYSIS WORKSHOP Final Report, 1992
Peggy L. Evanich (National Aeronautics and Space Administration, Washington, DC.), Thomas M. Crabb, and Charles F. Gartrell (General Research Corp., Vienna, VA.) 1 Dec. 1992 84 p Workshop held in Houston, TX, 12-14 May 1992
(Contract NASw-4470)
(NASA-CR-4467; NAS 1.26:4467) Avail: CASI HC A05/MF A01

The 1992 Life Support Systems Analysis Workshop was sponsored by NASA's Office of Aeronautics and Space Technology (OAST) to integrate the inputs from, disseminate information to, and foster communication among NASA, industry, and academic specialists. The workshop continued discussion and definition of key issues identified in the 1991 workshop, including: (1) modeling and experimental validation; (2) definition of systems

analysis evaluation criteria; (3) integration of modeling at multiple levels; and (4) assessment of process control modeling approaches. Through both the 1991 and 1992 workshops, NASA has continued to seek input from industry and university chemical process modeling and analysis experts, and to introduce and apply new systems analysis approaches to life support systems. The workshop included technical presentations, discussions, and interactive planning, with sufficient time allocated for discussion of both technology status and technology development recommendations. Key personnel currently involved with life support technology developments from NASA, industry, and academia provided input to the status and priorities of current and future systems analysis methods and requirements. Author

N93-27121# Federal Aviation Agency, Oklahoma City, OK. Civil Aeromedical Inst.

COMPARISON OF PORTABLE CREWMEMBER PROTECTIVE BREATHING EQUIPMENT (CPBE) DESIGNS Final Report

Bruce Wilcox, Jr., Garnet McLean, and Harvey England, Jr. Apr. 1993 11 p Sponsored by FAA Office of Aviation Medicine, Washington, DC (DOT/FAA/AM-93/6) Avail: CASI HC A03/MF A01

Crewmemeber protective breathing equipment (CPBE) presently certified for transport category aircraft employ 3 types of oxygen production systems: chlorate candle, potassium superoxide, and compressed oxygen. CPBE performance was evaluated to expose significant differences based on this distinction. CPBE tests employing humans were conducted in accordance with FAA Technical Standard Order C-116. All CPBE were tested for oxygen production, carbon dioxide concentration, internal temperature, moisture, and breathing resistance for 15 minutes at ground level (1,300 ft) and cabin altitude (8,000 ft), while subjects exercised. All CPBE produced a mean oxygen level of at least 59 percent and maintained carbon dioxide level below 5 percent at ground level. Differences in internal temperature and humidity were found. Performance at altitude generally paralleled these findings. Oxygen and carbon dioxide levels provide little discrimination about the relative merits of particular CPBE. However, differences in the wearability of CPBE, based on internal temperature, humidity, and weight, were dependent on the type of CPBE oxygen production system. Author

N93-27847*# Vanderbilt Univ., Nashville, TN.

EVA GLOVE RESEARCH TEAM Annual Report

Alvin M. Strauss, Steven W. Peterson, John A. Main, Rueben D. Dickenson, Bobby L. Shields, and Christine H. Lorenz (Vanderbilt Univ. Hospital, Nashville, TN.) Jul. 1992 83 p

(Grant NAGw-2546)

(NASA-CR-193014; NAS 1.26:193014) Avail: CASI HC A05/MF A01

The goal of the basic research portion of the extravehicular activity (EVA) glove research program is to gain a greater understanding of the kinematics of the hand, the characteristics of the pressurized EVA glove, and the interaction of the two. Examination of the literature showed that there existed no acceptable, non-invasive method of obtaining accurate biomechanical data on the hand. For this reason a project was initiated to develop magnetic resonance imaging as a tool for biomechanical data acquisition and visualization. Literature reviews also revealed a lack of practical modeling methods for fabric structures, so a basic science research program was also initiated in this area. For individual titles, see N93-27848 through N93-27850.

N93-27848*# Vanderbilt Univ., Nashville, TN.

A FEASIBILITY STUDY OF HAND KINEMATICS FOR EVA ANALYSIS USING MAGNETIC RESONANCE IMAGING

Rueben D. Dickenson, Christine H. Lorenz (Vanderbilt Univ. Hospital, Nashville, TN.), Steven W. Peterson, Alvin M. Strauss, and John A. Main *In its* EVA Glove Research Team Jul. 1992 11 p Presented at the 22nd International Conference on Environmental Systems, Seattle, WA, 13-16 Jul. 1992 (For primary document see N93-27847 10-54)

Avail: CASI HC A03/MF A01

A new method of analyzing the kinematics of joint motion is developed. Magnetic Resonance Imaging (MRI) offers several distinct advantages. Past methods of studying anatomic joint motion have usually centered on four approaches. These methods are x-ray projection, goniometric linkage analysis, sonic digitization, and landmark measurement of photogrammetry. Of these four, only x-ray is applicable for in vivo studies. The remaining three methods utilize other types of projections of inter-joint measurements, which can cause various types of error. MRI offers accuracy in measurement due to its tomographic nature (as opposed to projection) without the problems associated with x-ray dosage. Once the data acquisition of MR images was complete, the images were processed using a 3D volume rendering workstation. The metacarpalphalangeal (MCP) joint of the left index finger was selected and reconstructed into a three-dimensional graphic display. From the reconstructed volumetric images, measurements of the angles of movement of the applicable bones were obtained and processed by analyzing the screw motion of the MCP joint. Landmark positions were chosen at distinctive locations of the joint at fixed image threshold intensity levels to ensure repeatability. The primarily two dimensional planar motion of this joint was then studied using a method of constructing coordinate systems using three (or more) points. A transformation matrix based on a world coordinate system described the location and orientation of a local target coordinate system. Future research involving volume rendering of MRI data focusing on the internal kinematics of the hand's individual ligaments, cartilage, tendons, etc. will follow. Its findings will show the applicability of MRI to joint kinematics for gaining further knowledge of the hand-glove (power assisted) design for extravehicular activity (EVA).

Derived from text

N93-27849*# Vanderbilt Univ., Nashville, TN.

A PRELIMINARY STRUCTURAL ANALYSIS OF SPACE-BASED INFLATABLE TUBULAR FRAME STRUCTURES

John A. Main, Steven W. Peterson, and Alvin M. Strauss *In its* EVA Glove Research Team Jul. 1992 7 p (For primary document see N93-27847 10-54)

Avail: CASI HC A02/MF A01

The use of inflatable structures has often been proposed for aerospace and planetary applications. The advantages of such structures include low launch weight and easy assembly. The use of inflatables for applications requiring very large frame structures intended for aerospace use are proposed. In order to consider using an inflated truss, the structural behavior of the inflated frame must be examined. The statics of inflated tubes as beams was discussed in the literature, but the dynamics of these elements has not received much attention. In an effort to evaluate the vibration characteristics of the inflated beam a series of free vibration tests of an inflated fabric cantilevers were performed. Results of the tests are presented and models for system behavior posed. Author (revised)

N93-27850*# Vanderbilt Univ., Nashville, TN.

POWER ASSIST EVA GLOVE DEVELOPMENT

John A. Main, Steven W. Peterson, and Alvin M. Strauss *In its* EVA Glove Research Team Jul. 1992 17 p Presented at the 22nd International Conference on Environmental Systems, Seattle, WA, 13-16 Jul. 1992 (For primary document see N93-27847 10-54)

Avail: CASI HC A03/MF A01

Structural modeling of the EVA glove indicates that flexibility in the metacarpophalangeal (MCP) joint can be improved by selectively lowering the elasticity of the glove fabric. Two strategies are used to accomplish this. One method uses coil springs on the back of the glove to carry the tension in the glove skin due to pressurization. These springs carry the loads normally borne by the glove fabric, but are more easily deformed. An active system was also designed for the same purpose and uses gas filled bladders attached to the back of the EVA glove that change the dimensions of the back of the glove and allow the glove to bend at the MCP joint, thus providing greater flexibility at this joint. A threshold control scheme was devised to control the action of the joint actuators. Input to the controller was provided by thin resistive pressure sensors placed between the hand and the pressurized glove. The pressure sensors consist of a layer of polyester film that has a thin layer of ink screened on the surface. The resistivity of the ink is pressure dependent, so an extremely thin pressure sensor can be fabricated by covering the ink patch with another layer of polyester film and measuring the changing resistance of the ink with a bridge circuit. In order to sense the force between the hand and the glove at the MCP joint, a sensor was placed on the palmar face of the middle finger. The resultant signal was used by the controller to decide whether to fill or exhaust the bladder actuators on the back of the glove. The information from the sensor can also be used to evaluate the effectiveness of a given control scheme or glove design since the magnitude of the measured pressures gives some idea of the torque required to bend a glove finger at the MCP joint. Tests of this actuator, sensor, and control system were conducted in an 57.2 kPa glove box by performing a

series of 90 degree finger bends with a glove without an MCP joint assembly, a glove with the coil spring assembly, and with the four fingered actuated glove. The tests of these three glove designs confirm the validity of the model. Author

N93-27851# Hilton Systems, Inc., Cherry Hill, NJ.
AGE 60 PROJECT: CONSOLIDATED DATABASE EXPERIMENTS Final Report
Edwin J. Kay (Lehigh Univ., Bethlehem, PA.), Regina M. Harris, Robert S. Voros (Lehigh Univ., Bethlehem, PA.), Donald J. Hillman (Lehigh Univ., Bethlehem, PA.), Diane T. Hyland (Lehigh Univ., Bethlehem, PA.), and James D. Deimler Mar. 1993 96 p
(Contract DTFA02-90-90125)
(HS-TR-8025-3C(R2)) Avail: CASI HC A05/MF A01

Statistical analysis on historical data was conducted to investigate the relationship between pilot age and accident rates. The ultimate long-term aim of the Age 60 Project was to enhance aviation safety by increasing understanding about the relationships among pilot age, experience, and accident rates. The specific aims of the project were: to consolidate the currently separate databases related to pilot certification and aviation accidents and incidents; and to use this consolidated database to statistically examine the relationships that exist among chronological age, accidents, and other factors. Although the study was primarily directed at pilots who fly for FAR Part 121 air carriers who are subject to the Age 60 Rule, additional analyses were conducted for other categories of pilots to take advantage of additional data available for active pilots beyond the age of 60, and to further examine the influence of confounding factors. Derived from text

N93-27927# Search Technology, Inc., Norcross, GA.
SPECIFICATION OF ADAPTIVE AIDING SYSTEMS Final Report, 30 Mar. - 30 Nov. 1990
Robert C. Andes, Jr. and William B. Rouse Jul. 1992 72 p
(Contract F33615-88-C-3612)
(AD-A263071; STI-TR-8925-001; NAWCADWAR-92086-60) Avail: CASI HC A04/MF A01

Designers' decision making in specifying adaptive aiding systems is considered. A study of design decisions in specifying aiding for a fighter aircraft mission scenarios is discussed. The requisite background knowledge required for the design of aiding systems and inherent complexity of situations to which adaptive aiding is applicable is quite broad. Considering these facts, the initial analysis of aiding designer's decision processes focused on identification and validation of solutions currently used in the design process. Results indicate a high degree of consistency on the part of individual designers. However, there were substantial variations among designers in terms of both decisions made and information used to make the decisions. The implications of these results for development of design tools, as well as the types of research studies whose results would be valued by designers, are considered. DTIC

N93-28112# Mainstream Engineering Corp., Rockledge, FL.
LIGHTWEIGHT PASSIVE MICROCLIMATE COOLING DEVICE Final Report, Aug. 1991 - Mar. 1992
Clyde F. Parrish and Robert P. Scaringe Mar. 1993 65 p
(AD-A262262; NATICK-TR-93/014) Avail: CASI HC A04/MF A01

The intermittent adsorption cooling concept has been successfully demonstrated and has produced cooling rates in the 300 W range. The design requirement of 300 W for 6 hours has not been demonstrated due to system leaks. However, we demonstrated in laboratory experiments that were scaled to a much smaller size that we have produced 325 to 432 V of cooling. Laboratory experiments also showed the system could operate for more than 8 hours, be started and stopped, when the system contained no leaks. The current prototype was constructed of brass and copper for ease of fabrication. No consideration was given to weight. We have examined alternate methods of construction of the backpack and cylinder assembly and thin (0.01 in.) stainless steel could be used. The stainless steel sheet stock could be formed into a backpack bedding the sheets into fins, which also serve to strengthen the backpack. Also, stainless steel could be used to lower the weight of the cylinders. With these changes, the system weight including water and desiccant, is 23.8 lb. DTIC

N93-27177 Technion - Israel Inst. of Tech., Haifa. Faculty of Aerospace Engineering.
VISUAL FIELD INFORMATION IN NAP-OF-THE-EARTH FLIGHT BY TELEOPERATED HELMET-MOUNTED DISPLAYS
Arthur J. Grunwald, S. Kohn, and S. J. Merhav *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 78-97 (For primary document see N93-27166 10-01)
Copyright Avail: Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel

N93-27718*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
ENVIRONMENTAL CONTROL AND LIFE SUPPORT SYSTEM
Charles Ray and Alan Adams *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems 1990 p 317-341 (For primary document see N93-27704 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

N93-27719*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
ENVIRONMENTAL CONTROL AND LIFE SUPPORT SYSTEM EVOLUTION
Paul Wieland *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems 1990 p 343-365 (For primary document see N93-27704 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

N93-27720*# McDonnell-Douglas Space Systems Co., Huntsville, AL.
TECHNOLOGIES FOR ECLSS EVOLUTION
Bryce L. Diamant *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems 1990 p 367-493 (For primary document see N93-27704 10-18)
(Contract NAS8-36407)
Avail: CASI HC A05/MF A04; 1 functional color page

N93-27721*# Texas A&M Univ., College Station. Space Research Center.
ALTERNATIVE PROCESSES FOR WATER RECLAMATION AND SOLID WASTE PROCESSING IN A PHYSICAL/CHEMICAL BIOREGENERATIVE LIFE SUPPORT SYSTEM
Tom D. Rogers *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems 1990 p 495-515 (For primary document see N93-27704 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

N93-27722*# Wyle Labs., Inc., Huntsville, AL.
INCREASED FIRE AND TOXIC CONTAMINANT DETECTION RESPONSIBILITY BY USE OF DISTRIBUTED, ASPIRATING SENSORS
Wallace W. Youngblood *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems 1990 p 517-541 (For primary document see N93-27704 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

N93-27723*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
THE ECLSS ADVANCED AUTOMATION PROJECT EVOLUTION AND TECHNOLOGY ASSESSMENT
Brandon S. Dewberry, James R. Carnes (Boeing Co., Huntsville, AL.), Brenda D. Lukefahr (Alabama Univ., Huntsville.), John S. Rogers (Alabama Univ., Huntsville.), Daniel M. Rochowiak (Alabama Univ., Huntsville.), James W. McKee (Alabama Univ., Huntsville.), and Brian L. Benson (Alabama Univ., Huntsville.) *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems 1990 p 543-565 (For primary document see N93-27704 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

N93-27724*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
MARSHALL SPACE FLIGHT CENTER ECLSS TECHNOLOGY ACTIVITIES
Paul Wieland *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems 1990 p 567-598 (For primary document see N93-27704 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

N93-27725*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
JSC ECLSS R/T PROGRAM OVERVIEW
A. F. Behrend *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems 1990 p 599-619 (For primary document see N93-27704 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

N93-27787*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
EXTRAVEHICULAR ACTIVITY SYSTEM
Michael N. Rouen *In* NASA, Washington, Technology for Space Station Evolution. Volume 3: EVA/Manned Systems/Fluid Management System 1990 p 5-31 (For primary document see N93-27786 10-18)
Avail: CASI HC A03/MF A03; 1 functional color page

N93-27788*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
MAN-SYSTEMS DISTRIBUTED SYSTEM FOR SPACE STATION FREEDOM
J. L. Lewis *In* NASA, Washington, Technology for Space Station Evolution. Volume 3: EVA/Manned Systems/Fluid Management System 1990 p 33-56 (For primary document see N93-27786 10-18)
Avail: CASI HC A03/MF A03; 1 functional color page

N93-27789*# National Aeronautics and Space Administration, Washington, DC.
EVA/MANNED SYSTEMS
James P. Jenkins *In its* Technology for Space Station Evolution. Volume 3: EVA/Manned Systems/Fluid Management System 1990 p 59-68 (For primary document see N93-27786 10-18)
Avail: CASI HC A02/MF A03; 1 functional color page

N93-27790*# Hamilton Standard, Windsor Locks, CT. Space and Sea Systems.
EVOLUTION OF SPACE STATION EMU PLSS TECHNOLOGY RECOMMENDATIONS
Richard C. Wilde *In* NASA, Washington, Technology for Space Station Evolution. Volume 3: EVA/Manned Systems/Fluid Management System 1990 p 69-111 (For primary document see N93-27786 10-18)
Avail: CASI HC A03/MF A03; 1 functional color page

N93-27791*# McDonnell-Douglas Space Systems Co., Huntington Beach, CA.
EVOLVING EVA SYSTEM CAPABILITY FOR THE EVOLVING SPACE STATION FREEDOM REQUIREMENTS
Howard Slade *In* NASA, Washington, Technology for Space Station Evolution. Volume 3: EVA/Manned Systems/Fluid Management System 1990 p 113-119 (For primary document see N93-27786 10-18)
Avail: CASI HC A02/MF A03; 1 functional color page

N93-27792*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EVA AND TELEROBOT INTERACTION
Kelli F. Willshire *In* NASA, Washington, Technology for Space Station Evolution. Volume 3: EVA/Manned Systems/Fluid Management System 1990 p 121-139 (For primary document see N93-27786 10-18)
Avail: CASI HC A03/MF A03; 1 functional color page

N93-27793*# Lockheed Missiles and Space Co., Sunnyvale, CA. Astronautics Div.
SIMPLIFIED AID FOR CREW RESCUE (SAFR)
H. Thomas Fisher *In* NASA, Washington, Technology for Space Station Evolution. Volume 3: EVA/Manned Systems/Fluid Management System 1990 p 141-163 (For primary document see N93-27786 10-18)
Avail: CASI HC A03/MF A03; 1 functional color page

N93-27794*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
EVOLVING TECHNOLOGIES FOR SPACE STATION FREEDOM COMPUTER-BASED WORKSTATIONS
Dean G. Jensen and Marianne Rudisill *In* NASA, Washington, Technology for Space Station Evolution. Volume 3: EVA/Manned Systems/Fluid Management System 1990 p 165-179 (For primary document see N93-27786 10-18)
Avail: CASI HC A03/MF A03; 1 functional color page

N93-27795*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
MAN-SYSTEMS INTEGRATION AND THE MAN-MACHINE INTERFACE
Joseph P. Hale *In* NASA, Washington, Technology for Space Station Evolution. Volume 3: EVA/Manned Systems/Fluid Management System 1990 p 181-192 (For primary document see N93-27786 10-18)
Avail: CASI HC A03/MF A03; 1 functional color page

N93-27858*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
ENVIRONMENTAL CONTROL AND LIFE SUPPORT SYSTEMS
Charles D. Ray *In* NASA, Washington, Technology for Space Station Evolution. Executive Summary and Overview 1990 p 85-101 (For primary document see N93-27854 10-18)
Avail: CASI HC A03/MF A03; 1 functional color page

N93-27859*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
EXTRAVEHICULAR ACTIVITY TECHNOLOGY DISCIPLINE
Bruce W. Webbon *In* NASA, Washington, Technology for Space Station Evolution. Executive Summary and Overview 1990 p 103-117 (For primary document see N93-27854 10-18)
Avail: CASI HC A03/MF A03; 1 functional color page

N93-27860*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
MANNED SYSTEMS TECHNOLOGY DISCIPLINE
Remus Bretoi *In* NASA, Washington, Technology for Space Station Evolution. Executive Summary and Overview 1990 p 119-140 (For primary document see N93-27854 10-18)
Avail: CASI HC A03/MF A03; 1 functional color page

N93-27967*# Bechtel National, Inc., San Francisco, CA.
OXYGEN PRODUCTION ON THE LUNAR MATERIALS PROCESSING FRONTIER
Barbara H. Altenberg *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 14 p (For primary document see N93-27956 10-91)
Avail: CASI HC A03/MF A03

N93-27976*# Arizona Univ., Tucson. Environmental Research Lab.
CLOSED ECOLOGICAL SYSTEMS: FROM TEST TUBES TO EARTH'S BIOSPHERE
Robert J. Frye and George Mignon *In its* Proceedings of the Lunar Materials Technology Symposium Feb. 1992 19 p (For primary document see N93-27956 10-91)
Avail: CASI HC A03/MF A03

N93-27977*# United Technologies Corp., Farmington, CT. Hamilton Standard Div.
SPE WATER ELECTROLYZERS IN SUPPORT OF THE LUNAR OUTPOST
J. F. McElroy *In* Arizona Univ., Proceedings of the Lunar Materials

Technology Symposium Feb. 1992 20 p (For primary document see N93-27956 10-91)
Avail: CASI HC A03/MF A03

N93-27978*# Lockheed Engineering and Sciences Co., Houston, TX. Life Support Development Lab.
ASSESSMENT OF THE STATE OF THE ART IN LIFE SUPPORT ENVIRONMENTAL CONTROL FOR SEI
Charles H. Simonds and Gary P. Noyes *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 14 p (For primary document see N93-27956 10-91)
Avail: CASI HC A03/MF A03

N93-27979*# AiResearch Mfg. Co., Los Angeles, CA.
DUST PROTECTION FOR ENVIRONMENTAL CONTROL AND LIFE SUPPORT SYSTEMS IN THE LUNAR ENVIRONMENT
Susan Fuhs and Jeffrey Harris (Lockheed Corp., Houston, TX.) *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 12 p (For primary document see N93-27956 10-91)
Avail: CASI HC A03/MF A03

N93-27985*# Boeing Defense and Space Group, Huntsville, AL.
LUNAR BASE THERMAL MANAGEMENT/POWER SYSTEM ANALYSIS AND DESIGN
Jerry R. McGhee *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 12 p (For primary document see N93-27956 10-91)
Avail: CASI HC A03/MF A03

N93-28029# National Space Development Agency, Tokyo (Japan).
CONCEPTUAL STUDY ON MANNED LUNAR SURFACE SITE [YUUJIN GETSUMEN KYOTEN NO GAINEN KENTOU]
Yutaka Takano *In its* Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 17 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

N93-28031# Nippon Electric Co. Ltd., Tokyo (Japan).
CONCEPTUAL STUDY OF MANNED LUNAR SURFACE SITE [YUUJIN GETSUMEN KYOTEN NO GAINEN KENTOU]
Toshiaki Okudaira, Haruki Ayata, Kiyoshi Tanaka, Nobutaka Katou, and Naoki Yoshizawa *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 22 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

N93-28032# Ishikawajima-Harima Heavy Industries Co. Ltd., Tokyo (Japan).
MANNED LUNAR SURFACE SITE: CONCEPTUAL STUDY ON PRESSURIZED LUNAR SURFACE OPERATION ROVER [YUUJIN GETSUMEN KYOTEN: YOATSUGATA GETSUMEN SAGYOU ROBA NO GAINEN KENTOU]
Youichirou Nakamura, Keiko Yasuda, Isao Tate, Masaharu Takada, Shuuji Takahashi, and Michihiko Horie *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 21 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

N93-28033# Kawasaki Heavy Industries Ltd., Kobe (Japan).
MANNED LUNAR SURFACE SITE [YUUJIN GETSUMEN KYOTEN]
Terumitsu Kamata and Hiroyuki Torii *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 17 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

N93-28034# Ishikawajima-Harima Heavy Industries Co. Ltd., Tokyo (Japan).
LUNAR SURFACE EXPERIMENT SYSTEM [GETSUMEN JIKKEN SHISUTEMU]
Masakazu Takami, Seiko Hoshi, and Yuriko Oka *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 22 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

55 SPACE BIOLOGY

Includes exobiology; planetary biology; and extraterrestrial life.

No abstracts in this category.

59 MATHEMATICAL AND COMPUTER SCIENCES (GENERAL)

N93-26946*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
EXPLICIT ROBUST SCHEMES FOR IMPLEMENTATION OF A CLASS OF PRINCIPAL VALUE-BASED CONSTITUTIVE MODELS: SYMBOLIC AND NUMERIC IMPLEMENTATION
S. M. Arnold, A. F. Saleeb (Akron Univ., OH.), H. Q. Tan (Akron Univ., OH.), and Y. Zhang (Akron Univ., OH.) May 1993 55 p
(RTOP 510-01-50)
(NASA-TM-106124; E-7788; NAS 1.15:106124) Avail: CASI HC A04/MF A01

The issue of developing effective and robust schemes to implement a class of the Ogden-type hyperelastic constitutive models is addressed. To this end, special purpose functions (running under MACSYMA) are developed for the symbolic derivation, evaluation, and automatic FORTRAN code generation of explicit expressions for the corresponding stress function and material tangent stiffness tensors. These explicit forms are valid over the entire deformation range, since the singularities resulting from repeated principal-stretch values have been theoretically removed. The required computational algorithms are outlined, and the resulting FORTRAN computer code is presented. Author

N93-26947*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
EXPLICIT ROBUST SCHEMES FOR IMPLEMENTATION OF GENERAL PRINCIPAL VALUE-BASED CONSTITUTIVE MODELS
S. M. Arnold, A. F. Saleeb (Akron Univ., OH.), H. Q. Tan (Akron Univ., OH.), and Y. Zhang (Akron Univ., OH.) Apr. 1993 29 p
(RTOP 510-01-50)
(NASA-TM-106123; E-7787; NAS 1.15:106123) Avail: CASI HC A03/MF A01

The issue of developing effective and robust schemes to implement general hyperelastic constitutive models is addressed. To this end, special purpose functions are used to symbolically derive, evaluate, and automatically generate the associated FORTRAN code for the explicit forms of the corresponding stress function and material tangent stiffness tensors. These explicit forms are valid for the entire deformation range. The analytical form of these explicit expressions is given here for the case in which the strain-energy potential is taken as a nonseparable polynomial function of the principle stretches. Derived from text

N93-27014*# Communications Satellite Corp., Clarksburg, MD.
DIGITAL TRACKING LOOPS FOR A PROGRAMMABLE DIGITAL MODEM
John J. Poklemba Oct. 1992 29 p Presented at Milcom'92, San Diego, CA, 11-14 Oct. 1992; sponsored by IEEE
(Contract NAS3-25715; RTOP 506-72-21)
(NASA-CR-189219; E-7273; NAS 1.26:189219) Avail: CASI HC A03/MF A01

In this paper, an analysis and hardware emulation of the tracking loops for a very flexible programmable digital modem (PDM) will be presented. The modem is capable of being programmed for 2, 4, 8, 16-PSK, 16-QAM, MSK, and Offset-QPSK modulation schemes over a range of data rates from 2.34 to 300 Mbps with programmable spectral occupancy

from 1.2 to 1.8 times the symbol rate; these operational parameters are executable in burst or continuous mode. All of the critical processing in both the modulator and demodulator is done at baseband with very high-speed digital hardware and memory. Quadrature analog front-ends are used for translation between baseband and the IF center frequency. The modulator is based on a table lookup approach, where precomputed samples are stored in memory and clocked out according to the incoming data pattern. The sample values are predistorted to counteract the effects of the other filtering functions in the link as well as any transmission impairments. The demodulator architecture was adapted from a joint estimator-detector (JED) mathematical analysis. Its structure is applicable to most signalling formats that can be represented in a two-dimensional space. The JED realization uses interdependent, mutually aiding tracking loops with post-detection data feedback. To expedite and provide for more reliable synchronization, initial estimates for these loops are computed in a parallel acquisition processor. The cornerstone of the demodulator realization is the pre-averager received data filter which allows operation over a broad range of data rates without any hardware changes and greatly simplifies the implementation complexity. The emulation results confirmed tracking loop operation over the entire range of operational parameters listed above, as well as the capability of achieving and maintaining synchronization at BER's in excess of 10(exp -1). The emulation results also showed very close agreement with the tracking loop analysis, and validated the resolution apportionment of the various hardware elements in the tracking loops. Author (revised)

N93-27063*# Institute for Computer Applications in Science and Engineering, Hampton, VA.
CUMULATIVE REPORTS AND PUBLICATIONS
Washington Apr. 1993 92 p
(Contracts NAS1-19480; NAS1-18605; NAS1-18107; NAS1-17070; NAS1-17130; NAS1-15830; NAS1-16394; NAS1-14101; NAS1-14472; RTOP 505-90-52-01)
(NASA-CR-191440; NAS 1.26:191440) Avail: CASI HC A05/MF A01

A complete list of Institute for Computer Applications in Science and Engineering (ICASE) reports are listed. Since ICASE reports are intended to be preprints of articles that will appear in journals or conference proceedings, the published reference is included when it is available. The major categories of the current ICASE research program are: applied and numerical mathematics, including numerical analysis and algorithm development; theoretical and computational research in fluid mechanics in selected areas of interest to LaRC, including acoustics and combustion; experimental research in transition and turbulence and aerodynamics involving LaRC facilities and scientists; and computer science. Author (revised)

60 COMPUTER OPERATIONS AND HARDWARE

Includes hardware for computer graphics, firmware, and data processing.

For components see *33 Electronics and Electrical Engineering.*

N93-27051# Oak Ridge National Lab., TN.
CONSIDERATIONS FOR CONTROL SYSTEM SOFTWARE VERIFICATION AND VALIDATION SPECIFIC TO IMPLEMENTATIONS USING DISTRIBUTED PROCESSOR ARCHITECTURES
J. K. Munro, Jr. 1993 10 p Presented at the Meeting on Nuclear Plant Instrumentation, Control and Man-Machine Interface Technologies, Oak Ridge, TN, 18-21 Apr. 1993
(Contract DE-AC05-84OR-21400)
(DE93-007920; CONF-930401-2) Avail: CASI HC A02/MF A01

Until recently, digital control systems have been implemented on centralized processing systems to function in one of several ways: (1) as a single processor control system; (2) as a supervisor at the top of a hierarchical network of multiple processors; or (3) in a client-server mode. Each of these architectures uses a very different set of communication protocols. The latter two architectures also belong to the category of distributed control systems. Distributed control systems can have a central focus, as in the cases just cited, or be quite decentralized in a loosely coupled, shared responsibility arrangement. This last architecture is analogous to autonomous hosts on a local area network. Each of the architectures identified above will have a different set of architecture-associated issues to be addressed in the verification and validation activities during software development. This paper summarizes results of efforts to identify, describe, contrast, and compare these issues. DOE

N93-27239*# Illinois Univ. at Urbana-Champaign, Savoy. Coordinated Science Lab.
COMPILER-ASSISTED MULTIPLE INSTRUCTION ROLLBACK RECOVERY USING A READ BUFFER Ph.D. Thesis
Neal Jon Alewine Univ. of Illinois, Urbana, IL 22 Apr. 1993 149 p Sponsored by NASA. Ames Research Center
(NASA-CR-193102; NAS 1.26:193102; UILU-ENG-93-2215; CRHC-93-06)
Copyright Avail: CASI HC A07/MF A02

Multiple instruction rollback (MIR) is a technique to provide rapid recovery from transient processor failures and was implemented in hardware by researchers and slow in mainframe computers. Hardware-based MIR designs eliminate rollback data hazards by providing data redundancy implemented in hardware. Compiler-based MIR designs were also developed which remove rollback data hazards directly with data flow manipulations, thus eliminating the need for most data redundancy hardware. Compiler-assisted techniques to achieve multiple instruction rollback recovery are addressed. It is observed that data some hazards resulting from instruction rollback can be resolved more efficiently by providing hardware redundancy while others are resolved more efficiently with compiler transformations. A compiler-assisted multiple instruction rollback scheme is developed which combines hardware-implemented data redundancy with compiler-driven hazard removal transformations. Experimental performance evaluations were conducted which indicate improved efficiency over previous hardware-based and compiler-based schemes. Various enhancements to the compiler transformations and to the data redundancy hardware developed for the compiler-assisted MIR scheme are described and evaluated. The final topic deals with the application of compiler-assisted MIR techniques to aid in exception repair and branch repair in a speculative execution architecture. Author (revised)

N93-27372# Technische Univ., Eindhoven (Netherlands).
THE DESIGN OF CHIP ARCHITECTURES FOR ACCURATE INNER PRODUCT COMPUTATION Ph.D. Thesis
Ronald Johannes W. T Tangelder 1992 153 p
(ISBN-9-09-005204-6; ETN-93-93150) Copyright Avail: CASI HC A08/MF A02

A set of architectures is introduced, capable of exact computation of the floating point inner product. An inner product is the sum of products. To compute an inner product exactly, no rounding errors may be made at the computation of the product terms as well as the intermediate sum. The floating point numbers are elements of a finite set, and therefore, the product terms are also elements of a finite set. These product terms may be summed, without loss of precision to an intermediate sum and stored in an accumulator, which, though large, is finite. The performance of the architectures is analyzed. The actual implementation of the heart of the chip is presented. A flexible cell generator is introduced. Conclusions and suggestions for further work are given. ESA

N93-27614# Westinghouse Savannah River Co., Aiken, SC.
STRATEGIC PLAN FOR SCIENTIFIC COMPUTING
J. P. Church May 1992 18 p
(Contract DE-AC09-89SR-18035)
(DE93-006875; WSRC-TR-92-235) Avail: CASI HC A03/MF A01

Computing technology continues to undergo rapid and dramatic changes. Technological improvements in both hardware and software continue to permit analysts to model problems much more realistically than heretofore practicable. New visualization technologies vastly increase our ability to understand the results of those complex models. The mission of SRS is also undergoing very rapid change as a result of international events. While the typical demands of reactor oriented calculations may decline, environmental regulations require us to study new classes of problems in ever increasing detail. Hence, the computational workload is actually increasing rapidly. At the same time, the budget constraints demand a continued increase in cost effectiveness of scientific computing. A comprehensive strategy for scientific computing is required to adapt to these changes and still produce timely solutions to ensure continued safe

operation of SRS facilities. An important goal of this strategy is to ensure that productivity gains available with new systems and technologies are truly achieved. DOE

N93-27999# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
OPTIMAL MULTI-WRITER MULTI-READER ATOMIC REGISTER
Amos Israeli (Technion - Israel Inst. of Tech., Haifa.) and Amnon Shaham (Technion - Israel Inst. of Tech., Haifa.) Sep. 1992 36 p
(Contract NF-62-376)
(CWI-CS-R9235; ETN-93-93833) Copyright Avail: CASI HC A03/MF A01

The wide gap in space complexity of atomic, multiwriter, multireader register implementations is addressed. While the space complexity of all previous implementations is linear, the lower bounds are logarithmic. Two implementations which close this gap are presented. The first implementation uses multireader physical registers while the second uses single reader physical registers. Both implementations are optimal with respect to the two most important complexity criteria: their space complexity is logarithmic and their time complexity is linear. ESA

N93-28000# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
LINEAR-TIME SNAPSHOT PROTOCOLS FOR UNBALANCED SYSTEMS
Amos Israeli (Technion - Israel Inst. of Tech., Haifa.), Amnon Shaham (Technion - Israel Inst. of Tech., Haifa.), and Asaf Shirazi (Technion - Israel Inst. of Tech., Haifa.) Sep. 1992 13 p
(Contract NF-62-376)
(CWI-CS-R9236; ETN-93-93834) Copyright Avail: CASI HC A03/MF A01

The snapshot problem for shared memory systems is to enable a set of processors called scanners to obtain a consistent picture of the shared memory while other processors called updates keep updating memory locations concurrently. One of the most intriguing open problems in wait-free distributed computing is the existence of a linear time solution to this problem. It is shown that if the number of either scanners or updaters is smaller than the square root of the total number of processors then such a linear solution exists. ESA

N93-27708*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A FAULT-TOLERANT RISC MICROPROCESSOR FOR SPACECRAFT APPLICATIONS
Constantin Timoc (Spaceborn, Inc., La Canada, CA.) and Harry Benz *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems 1990 p 103-110 (For primary document see N93-27704 10-18)
Avail: CASI HC A02/MF A04; 1 functional color page

N93-27713*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EMBEDDED MULTIPROCESSOR TECHNOLOGY FOR VHSIC INSERTION
Paul J. Hayes *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems 1990 p 177-196 (For primary document see N93-27704 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

N93-27717*# Stanford Univ., CA. Computer Systems Lab.
AN OVERVIEW OF MCC AND ITS RESEARCH
Stephen F. Lundstrom *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems 1990 p 285-313 (For primary document see N93-27704 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

61 COMPUTER PROGRAMMING AND SOFTWARE

Includes computer programs, routines, alogorithms, and specific applications, e.g., CAD/CAM.

N93-26635# Economic Research Service, Washington, DC. Agriculture and Trade Analysis Div.
TS SOFTWARE USER MANUAL FOR THE TIME SERIES PROGRAM AND UTILITIES Staff Report
A. Webb, K. Gudmunds, and G. Hasha Feb. 1993 44 p
(PB93-167518; AGES-93-02) Avail: CASI HC A03/MF A01

TIME SERIES (TS) is a software program used to view graphs or tables of data from annual time series databases. It operates on IBM or compatible personal computers. A version of the software is distributed as PS&D VIEW, which includes annual data reported from more than 190 countries or regions for over 60 major agricultural commodities. The TS software greatly eases the review and initial analysis of this and other large PC databases. Features include the following: quick access to scrolling tables; chart plotting of series, trends, projections, and profiles; calculation of summary statistics; and data file exporting. The main program is accompanied by several utilities that allow users to build and manipulate annual databases for use in the TS program. The document describes the capabilities and use of the TS program and utilities. NTIS

N93-26897*# Institute for Computer Applications in Science and Engineering, Hampton, VA.
RELIABILITY ANALYSIS OF COMPLEX MODELS USING SURE BOUNDS Final Report
David M. Nicol (College of William and Mary, Williamsburg, VA.) and Daniel L. Palumbo Washington Mar. 1993 28 p Submitted for publication
(Contracts NAS1-18605; NAS1-19480; RTOP 505-90-52-01)
(NASA-CR-191445; NAS 1.26:191445; ICASE-93-14) Avail: CASI HC A03/MF A01

As computer and communications systems become more complex, it becomes increasingly more difficult to analyze their hardware reliability, because simple models may fail to adequately capture subtle but important model features. A number of ways in which this problem was addressed for analyses based upon White's SURE theorem are described. We point out how reliability analysis based on SURE mathematics can be extracted from a general C language description of the model behavior, how it can attack very large problems by accepting recomputation in order to reduce memory usage, how such analysis can be parallelized both on multiprocessors and on networks of ordinary workstations, and observe excellent performance gains by doing so. How the SURE theorem supports efficient Monte Carlo based estimation of reliability is discussed, and the advantages of the method are shown. Author (revised)

N93-26904*# Cornell Univ., Ithaca, NY. Dept. of Computer Science.
PROCESS MEMBERSHIP IN ASYNCHRONOUS ENVIRONMENTS
Aleta M. Ricciardi and Kenneth P. Birman 9 Feb. 1993 42 p Supersedes CU-TR-91-1188 Sponsored in part by IBM and Siemens Corp.
(Grant NAG2-593)
(NASA-CR-192977; NAS 1.26:192977; CU-TR-93-1328) Avail: CASI HC A03/MF A01

The development of reliable distributed software is simplified by the ability to assume a fail-stop failure model. The emulation of such a model in an asynchronous distributed environment is discussed. The solution proposed, called Strong-GMP, can be supported through a highly efficient protocol, and was implemented as part of a distributed systems software project at Cornell University. The precise definition of the problem, the protocol, correctness proofs, and an analysis of costs are addressed. Author (revised)

N93-27024*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
DYNAMIC GAS TEMPERATURE MEASUREMENTS USING A PERSONAL COMPUTER FOR DATA ACQUISITION AND REDUCTION
Gustave C. Fralick, Lawrence G. Oberle, and Lawrence C. Greer, III Apr. 1993 33 p

(RTOP 505-62-50)
(NASA-TM-106119; E-7777; NAS 1.15:106119) Avail: CASI HC A03/MF A01

This report describes a dynamic gas temperature measurement system. It has frequency response to 1000 Hz, and can be used to measure temperatures in hot, high pressure, high velocity flows. A personal computer is used for collecting and processing data, which results in a much shorter wait for results than previously. The data collection process and the user interface are described in detail. The changes made in transporting the software from a mainframe to a personal computer are described in appendices, as is the overall theory of operation. Author

N93-27070*# Institute for Computer Applications in Science and Engineering, Hampton, VA.
A MODELING STUDY OF THE TPC-C BENCHMARK Final Report
Scott T. Leutenegger (IBM Federal Systems Div., Yorktown Heights, NY.) and Daniel Dias (IBM Federal Systems Div., Yorktown Heights, NY.) Washington Mar. 1993 40 p Submitted for publication
(Contracts NAS1-19480; NAS1-18605; RTOP 505-90-52-01)
(NASA-CR-191443; NAS 1.26:191443; ICASE-93-12) Avail: CASI HC A03/MF A01

The TPC-C benchmark is a new benchmark approved by the TPC council intended for comparing database platforms running a medium complexity transaction processing workload. Some key aspects in which this new benchmark differs from the TPC-A benchmark are in having several transaction types, some of which are more complex than that in TPC-A, and in having data access skew. In this paper we present results from a modelling study of the TPC-C benchmark for both single node and distributed database management systems. We simulate the TPC-C workload to determine expected buffer miss rates assuming an LRU buffer management policy. These miss rates are then used as inputs to a throughput model. From these models we show the following: (1) we quantify the data access skew as specified in the benchmark and show what fraction of the accesses go to what fraction of the data; (2) we quantify the resulting buffer hit ratios for each relation as a function of buffer size; (3) we show that close to linear scale-up (about 3 percent from the ideal) can be achieved in a distributed system, assuming replication of a read-only table; (4) we examine the effect of packing hot tuples into pages and show that significant price/performance benefit can be thus achieved; and (5) by coupling the buffer simulations with the throughput model, we examine typical disk/memory configurations that maximize the overall price/performance. Author (revised)

N93-27071*# Analex Corp., Brook Park, OH.
ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE HIGH BURST RATE LINK EVALUATION TERMINAL POWER CONTROL AND RAIN FADE SOFTWARE TEST PLAN, VERSION 1.0 Final Report
Richard C. Reinhart May 1993 42 p
(Contract NAS3-25776; RTOP 679-50-OA)
(NASA-CR-189167; E-7817; NAS 1.26:189167) Avail: CASI HC A03/MF A01

The Power Control and Rain Fade Software was developed at the NASA Lewis Research Center to support the Advanced Communications Technology Satellite High Burst Rate Link Evaluation Terminal (ACTS HBR-LET). The HBR-LET is an experimenters terminal to communicate with the ACTS for various experiments by government, university, and industry agencies. The Power Control and Rain Fade Software is one segment of the Control and Performance Monitor (C&PM) Software system of the HBR-LET. The Power Control and Rain Fade Software automatically controls the LET uplink power to compensate for signal fades. Besides power augmentation, the C&PM Software system is also responsible for instrument control during HBR-LET experiments, control of the Intermediate Frequency Switch Matrix on board the ACTS to yield a desired path through the spacecraft payload, and data display. The Power Control and Rain Fade Software User's Guide, Version 1.0 outlines the commands and procedures to install and operate the Power Control and Rain Fade Software. The Power Control and Rain Fade Software Maintenance Manual, Version 1.0 is a programmer's guide to the Power Control and Rain Fade Software. This manual details the current implementation of the software from a technical perspective. Included is an overview of the Power Control and Rain Fade Software, computer algorithms, format representations, and computer hardware configuration. The Power Control and Rain Fade Test Plan provides a step-by-step procedure to verify the operation of the software using a predetermined signal fade event. The Test Plan also provides a means to demonstrate the capability of the software. Author

N93-27087*# George Mason Univ., Fairfax, VA. Dept. of Operations Research and Engineering.
STATISTICAL MODELING OF SOFTWARE RELIABILITY Semiannual Status Report No. 2, 1 Oct. 1991 - 31 Dec. 1992
Douglas R. Miller 31 Dec. 1992 46 p
(Grant NAG1-1241)
(NASA-CR-192986; NAS 1.26:192986) Avail: CASI HC A03/MF A01

This working paper discusses the statistical simulation part of a controlled software development experiment being conducted under the direction of the System Validation Methods Branch, Information Systems Division, NASA Langley Research Center. The experiment uses guidance and control software (GCS) aboard a fictitious planetary landing spacecraft: real-time control software operating on a transient mission. Software execution is simulated to study the statistical aspects of reliability and other failure characteristics of the software during development, testing, and random usage. Quantification of software reliability is a major goal. Various reliability concepts are discussed. Experiments are described for performing simulations and collecting appropriate simulated software performance and failure data. This data is then used to make statistical inferences about the quality of the software development and verification processes as well as inferences about the reliability of software versions and reliability growth under random testing and debugging. Author (revised)

N93-27224*# Research Inst. for Advanced Computer Science, Moffett Field, CA.
USRA/RIACS Final Report, 1 Jul. - 31 Dec. 1992
Joseph Oliger 31 Dec. 1992 15 p
(Contract NCC2-387)
(NASA-CR-193216; NAS 1.26:193216) Avail: CASI HC A03/MF A01

The Research Institute for Advanced Computer Science (RIACS) was established by the Universities Space Research Association (USRA) at the NASA Ames Research Center (ARC) on June 6, 1983. RIACS is privately operated by USRA, a consortium of universities with research programs in the aerospace sciences, under a cooperative agreement with NASA. The primary mission of RIACS is to provide research and expertise in computer science and scientific computing to support the scientific missions of NASA ARC. The research carried out at RIACS must change its emphasis from year to year in response to NASA ARC's changing needs and technological opportunities. A flexible scientific staff is provided through a university faculty visitor program, a post doctoral program, and a student visitor program. Not only does this provide appropriate expertise but it also introduces scientists outside of NASA to NASA problems. A small group of core RIACS staff provides continuity and interacts with an ARC technical monitor and scientific advisory group to determine the RIACS mission. RIACS activities are reviewed and monitored by a USRA advisory council and ARC technical monitor. Research at RIACS is currently being done in the following areas: (1) parallel computing; (2) advanced methods for scientific computing; (3) learning systems; (4) high performance networks and technology; and (5) graphics, visualization, and virtual environments. In the past year, parallel compiler techniques and adaptive numerical methods for flows in complicated geometries were identified as important problems to investigate for ARC's involvement in the Computational Grand Challenges of the next decade. We concluded a summer student visitors program during this six months. We had six visiting graduate students that worked on projects over the summer and presented seminars on their work at the conclusion of their visits. RIACS technical reports are usually preprints of manuscripts that have been submitted to research journals or conference proceedings. A list of these reports for the period July 1, 1992 through December 31, 1992 is provided. Derived from text

N93-27230# Technische Univ., Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
A LOCAL SEARCH TEMPLATE Extended Abstract
R. J. M. Vaessens, E. H. L. Aarts (Philips Gloeilampenfabrieken N.V., Eindhoven, Netherlands.), and J. K. Lenstra (Center for Mathematics and Computer Science, Amsterdam, Netherlands.) May 1992 15 p
(MEMO-COSOR-92-11; ETN-93-93167) Avail: CASI HC A03/MF A01

A unifying framework for the many different types of local search

algorithms in combinatorial optimization is proposed. A template that captures the majority of local search algorithms proposed in the literature, such as iterative improvement, simulated annealing, threshold accepting, tabu search, and genetic algorithms is presented. The template leads to a classification of existing local search algorithms and suggests direction for designing new types of local search approaches. ESA

N93-27243# Technische Univ., Eindhoven (Netherlands). Dept. of Electrical Engineering.

THE ASCIS DATA FLOW GRAPH SEMANTICS AND TEXTUAL FORMAT

J. T. J. vanEijndhoven, G. G. deJong, and L. Stok Jun. 1991 55 p (Contract BRA-3281)

(EUT-91-E-251; ISBN-9-06-144251-6; ETN-93-932156) Copyright Avail: CASI HC A04/MF A01

A data flow graph for the behavioral modeling of digital hardware is described. The graph is to be generated from known hardware behavioral description languages, and serves as interface to different architectural synthesis and formal verification packages. The graph has an accurate semantical definition, based on a token flow principle. As a result maximum freedom is obtained to generate different design tradeoffs, and typical restrictions of synthesis packages are removed. The textual format is based on keywords and braces, allowing local, or future extensions maintaining both upwards and downwards compatibility. ESA

N93-27246# Technische Univ., Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.

NEW LOWER AND UPPER BOUNDS FOR SCHEDULING AROUND A SMALL COMMON DATE

J. A. Hoogeveen, H. Oosterhout (Tilburg Univ., Netherlands.), and S. L. vandeVelde (Universiteit Twente, Enschede, Netherlands.) Jun. 1992 19 p

(MEMO-COSOR-92-18; ETN-93-93174) Avail: CASI HC A03/MF A01

Suppose a set of n jobs has to be scheduled on a single machine which can handle no more than one job at a time. The problem is to find a schedule that minimizes the sum of the deviations of the job completion times from a given common due date that is smaller than the sum of the processing times. Lagrangian relaxation is applied to find new lower and upper bounds in O(nlog n) time. This upper bound is used to develop a heuristic with both a good worst case and empirical behavior: its solution value is guaranteed to be no more than 4/3 times the optimal solution value, and always concurred with the lower bound for n equal to or greater than 50 in computational experiments with processing times drawn from different distributions over the integers 1,...,100. For the case where these bounds do not concur, a refinement of the lower bound is presented. This is obtained by solving a subset sum problem to optimality by a pseudo polynomial algorithm. If these bounds still do not concur, then branch-and-bound is applied; the computational results show that only little branching is needed. It is indicated to what extent the analysis also applies to the case that all early completions are weighted by a common weight alpha and all tardy completions by a common weight beta. ESA

N93-27247# Technische Univ., Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.

MINIMIZING TOTAL INVENTORY COST ON A SINGLE MACHINE IN JUST-IN-TIME MANUFACTURING

J. A. Hoogeveen and S. L. vandeVelde (Universiteit Twente, Enschede, Netherlands.) Jun. 1992 30 p

(MEMO-COSOR-92-20; ETN-93-93176) Avail: CASI HC A03/MF A01

A single machine scheduling problem with the objective of minimizing total inventory cost, comprising cost associated with work in process inventories and storage cost as a result of early completion, is investigated. The cost components are measured by the sum of the job completion times and the sum of the job earlinesses. This problem differs from more traditional scheduling problems, since the insertion of machine idle time may reduce total cost. The search for an optimal schedule, however, can be limited to the set of job sequences, since for any sequence there is clear-cut way to insert machine idle time in order to minimize total inventory cost. Branch-and-bound is applied to identify an optimal schedule. Five approaches for lower bound calculation, based upon relaxation of the objective function, of the state space, and upon Lagrangian relaxation are presented. ESA

N93-27248# Technische Univ., Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.

POLYNOMIAL-TIME ALGORITHMS FOR SINGLE-MACHINE BICRITERIA SCHEDULING

J. A. Hoogeveen and S. L. vandeVelde (Universiteit Twente, Enschede, Netherlands.) Jun. 1992 16 p

(MEMO-COSOR-92-21; ETN-93-93177) Avail: CASI HC A03/MF A01

The problem of scheduling n independent jobs on a single machine so as to minimize an objective function that is composed of total completion time and a minmax criterion is investigated. It is shown that, if the second criterion is maximum cost, then the problem is solvable in O(n cubed min (n, log n + log p(sub max)) time, where p(sub max) is the maximum job processing time, for every nondecreasing composite objective function. Second, it is shown that, if the second criterion is maximum promptness, then the problem is solved in O(n to the power of 4) time for every nondecreasing linear composite objective function if preemption is allowed or if total completion time outweighs maximum promptness. ESA

N93-27253# Technische Univ., Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.

PREPROCESSING AND PROBING TECHNIQUES FOR MIXED INTEGER PROGRAMMING PROBLEMS

M. W. P. Savelsbergh Jul. 1992 24 p

(MEMO-COSOR-92-26; ETN-93-93182) Avail: CASI HC A03/MF A01

An overview of simple and advanced preprocessing and probing techniques to improve the representation of a mixed integer program is given. The effectiveness of these techniques is demonstrated. Special attention is given to the identification of unfeasibility and redundancy, improvement of bounds and coefficients, and fixing of binary variables. Recent extensions to these basic techniques are discussed. The investigation and possible uses of logical consequences are developed. ESA

N93-27254# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.

FORMAL SPECIFICATION OF MANIFOLD: A PRELIMINARY STUDY

E. P. B. M. Rutten, F. Arbab, and I. Herman May 1992 37 p Sponsored in part by European Consortium in Informatics and Mathematics; CNR; CWI, Amsterdam, Netherlands; Ges. fuer Mathematik und Datenverarbeitung; INSEC, Portugal; INRIA; and Rutherford High Energy Lab., Chilton, England

(CWI-CS-R9215; ETN-93-93228) Copyright Avail: CASI HC A03/MF A01

An initial version of a formal specification of the MANIFOLD language is presented. An operational semantics of the event driven mechanism of the MANIFOLD language is given. MANIFOLD is a parallel programming language where processes called manifolds use an event driven control mechanism to coordinate the communications among other processes. Only the event mechanisms of MANIFOLD which handles the control aspect of the language is considered. The behavior of MANIFOLD is formally defined using transition systems at different structural levels. These transition systems define the control behavior of the MANIFOLD language constructs, from primitive actions to entire applications involving multitudes of concurrent processes. This formal specification is intended as a preliminary study. Analysis of the properties of this model has not yet been carried out. Continuation of this work includes clarification of the complete behavior of MANIFOLD, development of programming tools for analysis of MANIFOLD programs, further development of the MANIFOLD model, and possibly better models for its future implementations. ESA

N93-27255# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.

A THEORY OF FIRST-ORDER BUILT-IN'S OF PROLOG

Krzysztof R. Apt (Amsterdam Univ., Netherlands.), Elena Marchiori (Padua Univ., Italy.), and Catuscia Palamidessi (Pisa Univ., Italy.) Jun. 1992 18 p Presented at the 3rd International Conference on Algebraic and Logic Programming, Pisa, Italy, 1992 Submitted for publication Sponsored in part by EEC

(Grant CNR-89-00026-69)

(CWI-CS-R9216; ETN-93-93229) Copyright Avail: CASI HC A03/MF A01

The aim of the work is to provide a systematic account of the class of the built-in's of PROLOG. This class includes the arithmetic relations and

some metalogical relations. To distinguish them from those built-in's which refer to clauses and goals, they are called first-order built-in's. A framework for studying PROLOG programs with various built-in's that include arithmetic operations, and such metalogical relations like var and ground is provided. A new declarative semantics is proposed. The completeness of the PROLOG computation mechanisms is proven. A method for proving termination of PROLOG programs with built-in's which uses this semantics is given. The method is shown to be modular. ESA

N93-27256# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
TRANSITION SYSTEMS AND DYNAMIC SEMANTICS
R. Tim P. Fernando Jun. 1992 23 p Revised Submitted for publication Sponsored by Netherlands Organization for Scientific Research
(CWI-CS-R9217; ETN-93-93230) Copyright Avail: CASI HC A03/MF A01

Transition systems over first order models, first order theories, and families of first order models are constructed and examined in relation to dynamic semantics. Going the other direction, first order models are extracted from transition systems, bringing full circle the connection between static and dynamic notions. Only states computationally accessible from an initial state are considered, motivating the introduction of an internal notion of proposition in which the concept of an update is analyzed. ESA

N93-27257*# Computer Sciences Corp., Lanham, MD.
SOFTWARE MANAGEMENT ENVIRONMENT (SME) RELEASE 9.4 USER REFERENCE MATERIAL
R. Hendrick, D. Kistler, and K. Manter Sep. 1992 96 p
(Contract NAS5-31500)
(NASA-CR-193173; Rept-552-FDD-91/067ROUDO; NAS 1.26:193173; CSC/TM-91/6129ROUDO) Avail: CASI HC A05/MF A01

This document contains user reference material for the Software Management Environment (SME) prototype, developed for the Systems Development Branch (Code 552) of the Flight Dynamics Division (FDD) of Goddard Space Flight Center (GSFC). The SME provides an integrated set of management tools that can be used by software development managers in their day-to-day management and planning activities. This document provides an overview of the SME, a description of all functions, and detailed instructions concerning the software's installation and use. Author

N93-27291*# Virginia Univ., Charlottesville. Dept. of Computer Science.
DEVELOPMENT OF A SOFTWARE SAFETY PROCESS AND A CASE STUDY OF ITS USE Annual Progress Report
John C. Knight Jun. 1993 26 p
(Grant NAG1-1123)
(NASA-CR-193159; NAS 1.26:193159; UVA/528344/CS93/103) Avail: CASI HC A03/MF A01

The goal of this research is to continue the development of a comprehensive approach to software safety and to evaluate the approach with a case study. The case study is a major part of the project, and it involves the analysis of a specific safety-critical system from the medical equipment domain. The particular application being used was selected because of the availability of a suitable candidate system. We consider the results to be generally applicable and in no way particularly limited by the domain. The research is concentrating on issues raised by the specification and verification phases of the software lifecycle since they are central to our previously-developed rigorous definitions of software safety. The theoretical research is based on our framework of definitions for software safety. In the area of specification, the main topics being investigated are the development of techniques for building system fault trees that correctly incorporate software issues and the development of rigorous techniques for the preparation of software safety specifications. The research results are documented. Another area of theoretical investigation is the development of verification methods tailored to the characteristics of safety requirements. Verification of the correct implementation of the safety specification is central to the goal of establishing safe software. The empirical component of this research is focusing on a case study in order to provide detailed characterizations of the issues as they appear in practice, and to provide a testbed for the evaluation of various existing and new theoretical results, tools, and techniques. The Magnetic Stereotaxis System is summarized Derived from text

N93-27363# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
A COMPARISON OF OBJ3 AND ASF+SDF
S. M. Eker Jul. 1992 27 p
(CWI-CS-R9223; ETN-93-93235) Copyright Avail: CASI HC A03/MF A01

The features of two current algebraic specification languages are contrasted. Their performances in a suite of benchmark programs are compared. Algebraic specification languages offer a declarative programming paradigm which has simpler semantics than that of higher order functional languages. On top of the basic signature plus equations model, practical algebraic specification languages provide extensions to support the construction of large readable programs. Such extensions include modules, user definable syntax and enhanced pattern matching. Two current algebraic specification languages are OBJ3 and ASF+SDF. OBJ3 is the latest in a series of algebraic specification languages developed and is based on a refinement of many sorted algebra called order sorted algebra. The ASF+SDF language results from the fusion of the Algebraic Specification Formalism and the Syntax Definition Formalism. ESA

N93-27369# Utrecht State Univ. (Netherlands). Dept. of Computer Science.
USING CACHED FUNCTIONS AND CONSTRUCTORS FOR INCREMENTAL ATTRIBUTE EVALUATION
Maarten Pennings, Doaitse Swierstra, and Harald Vogt Mar. 1992 16 p
(RUU-CS-92-11; ETN-93-93280) Avail: CASI HC A03/MF A01

A technique for the efficient incremental evaluation of attribute grammars is presented. The applied approach may also be effective in the evaluation of higher-order attribute grammars. The approach is an extension of a simpler algorithm for incremental evaluation, where functions, corresponding to visit sequences, are cached. Attributes are now either found in the cache or they are recomputed, so there is no longer a need to represent the attributed tree explicitly. Common subtrees can be shared. The following change is proposed: instead of explicitly representing the tree and calling visit sequence functions to compute the attributes, the tree is represented through a set of visit functions corresponding to the successive visits. These functions are constituted using the visit sequences as building blocks. This technique has two major advantages. Firstly, a visit function characterizes precisely that part of the tree that would actually be visited in the previous approach, thus increasing the number of cache hits. Secondly, copy rules may be removed during the construction phase. This results in short circuiting the copychains and in minimizing the number of recomputed functions. ESA

N93-27377# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
ASSOCIATIVE MATCHING FOR LINEAR TERMS
S. M. Eker Jul. 1992 29 p
(CWI-CS-R9224; ETN-93-93236) Copyright Avail: CASI HC A03/MF A01

Associative matching is a feature supported by current algebraic specification languages. Deciding the existence of a match modulo associativity is known to be NP-complete in general. It is shown that for a linear pattern term p and a subject term s the existence of a match modulo associativity can be decided in O((absolute value of P) x (absolute value of s)) time. An algorithm is given and it is shown that there exists a family of associative matching problems with linear pattern terms on which the naive algorithm takes exponential time to discover that no matching substitutions exist. The main result is a new algorithm for building a graph based data structure in O((absolute value of p) x (absolute value of s)) time and space which encodes the complete set of flattened matching substitutions and from which each flattened matching substitution can be extracted in O(absolute value of Var(p)). It is also discussed how this algorithm could be applied to the general associative matching problem, however in this case the existence of a match cannot be easily determined from the graph based data structure and the complexity result for extracting matching substitutions is lost. ESA

N93-27378# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
VERIFICATION OF PARAMETERISED SYNCHRONOUS CONCURRENT ALGORITHMS WITH OBJ3: THE PIXEL PLANES ARCHITECTURE REVISITED
S. M. Eker Jul. 1992 20 p
(CWI-CS-R9225; ETN-93-93237) Copyright Avail: CASI HC A03/MF A01

The verification of parameterized synchronous concurrent algorithms using OBJ3 is presented. The case study is the linear expression evaluator from the pixel planes graphics architecture which was previously manually verified and also verified using OBJ3 in the fixed size nonparameterized case. A Synchronous Concurrent Algorithm (SCA) consists of a network of modules and channels which are synchronized by a global clock and compute and communicate data in parallel. Many algorithms and architectures can be formalized as SCA's including clocked hardware. The mathematical theory of SCA's is based on the computable functions over many sorted algebras. The pixel planes architecture is a high performance graphics system that contains a tree structured computation unit called a Linear Expression Evaluator (LEE). The equations defining a LEE tree of fixed height were translated into OBJ3 and a correctness proof obtained by term rewriting. This work is extended to the case where the height of the LEE tree is a parameter n and it is verified for all n by using induction over tree paths. ESA

N93-27379# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.
FINDING k DISJOINT PATHS IN A DIRECTED PLANAR GRAPH
Alexander Schrijver (Amsterdam Univ., Netherlands.) Apr. 1992 10 p
(CWI-BS-R9206; ETN-93-93246) Copyright Avail: CASI HC A02/MF A01

It is shown, that for each fixed k, the problem of finding k pairwise vertex-disjoint directed paths between given terminals in a directed planar graph is solvable in polynomial time. The k disjoint paths problems for directed planar graphs is shown to be solvable in polynomial time, for any fixed k: given a directed planar graph D = (V, A) and k pairs (r(sub 1), s(sub 1),...,(r(sub k), s(sub k)) of vertices of D; find k pairwise vertex-disjoint directed paths P(sub 1),...,P(sub k) in D, where P(sub i) runs from r(sub i) to s(sub i) (i = 1,..., k). The problem is NP complete if k is not fixed. Moreover, it is NP complete for k = 2 if the planarity condition is deleted. The method proposed is based on cohomology over free groups. ESA

N93-27385# Technische Univ., Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
MP-DIT: MATHEMATICAL PROGRAM DATA INTERCHANGE TOOL
Marek Makowski (International Inst. for Applied Systems Analysis, Laxenburg, Austria.) and Martin W. P. Savelsbergh Aug. 1992 16 p
(Memo-COSOR-92-31; ETN-93-93187) Avail: CASI HC A03/MF A01

Some ideas on a data interchange tool for mathematical programming are given. The tools considered are those that can be used in sophisticated modeling environments to link data bases, modeling languages, report generators, and solvers. An important step towards software integration is the definition of standard interfaces between the components: the MPS is the only available interface. In view of the growing importance of modeling environments and the associated challenge of software integration, some alternatives to the MPS format must be considered. ESA

N93-27386# *Universiteit Twente, Enschede (Netherlands). Tele-Informatics* and Open Systems Group.
A DESIGN AND REALIZATION EXERCISE OF A MINI MESSAGE TRANSFER SYSTEM
I. Widya, R. deBos, and M. vanSinderen 1992 21 p
(Memo-INF-92-51; TIOS-92-23; ETN-93-93205) Copyright Avail: CASI HC A03/MF A01

An exercise in the design and the realization of a distributed application layer protocol according to an integrated design method is presented. The applied method is a basically topdown method which encourages a cyclic design approach and which incorporates the use of the formal description technique LOTOS. LOTOS is viewed as a broad spectrum language that can be used in several successive phases of a design process. A simple message transfer system is chosen as the design example and UNIX workstations with a running ISO Development Environment (ISODE) are used as the target realization environment. The rationale of the design steps with an emphasis on the problem of mapping LOTOS constructs into UNIX/ISODE structures is presented. ESA

N93-27387# Universiteit Twente, Enschede (Netherlands). Dept. of Computer Science.
PRIORITY INHERITANCE IN REAL-TIME MICRO KERNELS
Pierre G. Jansen and Fred Gansevles Jul. 1992 14 p
(Memo-INF-92-52; ETN-93-93206) Copyright Avail: CASI HC A03/MF A01

Several synchronization policies are reviewed and a new one is proposed in which the shortcomings of the existing policies are avoided. The purpose of the research is to develop a real time scheduling policy for a multimedia environment. Existing policies are described and compared with the proposed one. The research is part of the multimedia Huygens project. Priority inversion occurs if a high priority thread is waiting for a low priority thread that may not continue due to its low priority. In a real time system such a phenomenon should not be tolerated. It can be accorded by letting a low priority thread inherit the highest priority of its waiting threads. ESA

N93-27388# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
SPECIFICATION OF MANIFOLD, VERSION 1.0
F. Arbab Jun. 1992 70 p
(CWI-CS-R9220; ETN-93-93233) Copyright Avail: CASI HC A04/MF A01

Management of the communications along a set of concurrent processes arises in many applications and is a central concern in parallel and distributed computing. A coordination language for managing complex interconnections among sets of independent, concurrent, cooperating processes, named MANIFOLD, is introduced. The MANIFOLD system is suitable for massively parallel environments. Both the conceptual model of MANIFOLD and the specification of the MANIFOLD language are presented. The conceptual model behind MANIFOLD is based on the principle of separating functionality from communication. This model leads to a simple but conventional model of communication. Contrary to most other models, computation in MANIFOLD is built out of communications. The primary concern in the MANIFOLD language is in how these processes are interconnected and how their interaction patterns change during the execution life of the system. ESA

N93-27389# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
COMPARATIVE TRANSITION SYSTEM SEMANTICS
R. T. P. Fernando Jul. 1992 24 p Sponsored by Netherlands Organization for Scientific Research
(CWI-CS-R9222; ETN-93-93234) Copyright Avail: CASI HC A03/MF A01

The notion of a transition system is employed to relate programs, conceived as binary (transition) relations on states, to processes, viewed as dynamic states. The comparative study is carried out syntactically through the enumeration of rules for transitions, and semantically in terms of bisimulation equivalence. A certain form of transitions is studied. Sequential composition, nondeterministic choice, iteration, and interleaving are analyzed alongside a notion of data. Atomization and synchronization are also considered. An informal account of five transition systems from dynamic logic, process algebra and the ground in between, is given. A static study based on a single unifying transition system is presented. A semantics for (P1) is worked out, providing an 'alternative' approach to the notion of a bisimulation designed for (P2). The different transition systems are semantically related by analyzing models that are in a suitable sense final. Directions for further work are discussed and an appendix containing certain technical details is included. ESA

N93-27390# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
CLOSED G(SUP 1)-CONTINUOUS CUBIC BEZIER SURFACES
Remco C. Veltkamp Jul. 1992 23 p
(CWI-CS-R9226; ETN-93-93238) Copyright Avail: CASI HC A03/MF A01

An analysis of the sufficient and necessary polynomial degree for several scattered data interpolation problems is presented. The attention is focused

on the construction of a piecewise triangular cubic Bezier surface that interpolates given triangle vertices with prescribed normal vectors, and is G(sup 1) continuous everywhere. In order to get enough degrees of freedom to define the Bezier control points, a triangle three split, a two split and a six split scheme are developed. The split into six subtriangles results in a surface that is G(sup 1) continuous as well as visually pleasing. ESA

N93-27391# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.

A PREDICATE TRANSFORMER FOR UNIFICATION

Livio Colussi (Padua Univ., Italy.) and Elena Marchiori (Padua Univ., Italy.) Jul. 1992 19 p Presented at the Joint International Conference a nd Symposium on Logic Programming, Washington, DC, 1992 Submitted for publication

(CWI-CS-R9227; ETN-93-93239) Copyright Avail: CASI HC A03/MF A01

Unification as predicate transformer is studied. Given a unification problem expressed as a set of sets of terms U and a predicate P, the authors are interested in the strongest predicate R such that if P holds before the unification of U then R holds when the unification is performed. A Dijkstra-style calculus that given P and U computes R is introduced. The soundness, completeness and termination of the calculus are proven. The predicate language considered contains monotonic predicates together with some nonmonotonic predicates. This allows to use the calculus for the static analysis of run time properties of PROLOG programs. ESA

N93-27392# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.

AN ANALYTICAL SOLUTION TO THE CONSISTENCY PROBLEM FOR THE LITTLEWOOD MODEL IN SOFTWARE RELIABILITY

Leo G. Barendrect and Mark C. J. vanPul Dec. 1991 27 p

(CWI-BS-R9129; ETN-93-93240) Copyright Avail: CASI HC A03/MF A01

Two different approaches to construct estimators for the model parameters of the Littlewood model are considered and whether they are consistent or not is investigated. Littlewood's parametric software reliability model is presented. The maximum likelihood estimation method for counting processes is discussed. It is shown that for the software reliability model of Littlewood, the likelihood equations can have more than one solution. It is also shown how an initial estimator, that is square root of n-consistent, can be found. An algorithm that produces an asymptotically efficient estimator is described. A second, more analytical approach to the problem, exploiting the mathematical properties of the log-likelihood function of the Littlewood model is described. The results of the two methods are compared. ESA

N93-27394# National Aerospace Lab., Amsterdam (Netherlands). Informatics Div.

TIME-STEP ENLARGEMENT FOR RUNGE-KUTTA INTEGRATION ALGORITHMS BY IMPLICIT SMOOTHING

M. vanLoon 19 Jun. 1991 93 p

(NLR-TP-91229-U; ETN-93-93323) Avail: CASI HC A05/MF A01

An investigation on how the maximum time step of an explicit Runge-Kutta time integration algorithm can be enlarged by implicit numerical smoothing is presented. This is important for numerical flow simulations. The following analysis methods are used: stability analysis with discrete Fourier analysis; variational analysis of discrete expressions; Courant Friedrich Lewy (CFL) max determination by numerical optimization; and numerical simulation, with a few one dimensional time dependent model problems. It was concluded that implicit smoothing allows a considerable enlargement of the maximum time step for stable numerical integration if the numerical solution is smooth. ESA

N93-27408# National Inst. of Standards and Technology, Gaithersburg, MD. Factory Automation Systems Div.

USER'S GUIDE FOR THE ALGORITHM TESTING SYSTEM/VERSION 1.1

C. Diaz Feb. 1993 45 p Sponsored by NRL

(PB93-175990; NISTIR-5137) Avail: CASI HC A03/MF A01

The National Institute of Standards and Technology (NIST) Algorithm Testing System (ATS) is a software package for evaluating the performance of geometric fitting software. The report is a user's guide to the ATS. The user's guide documents the detailed description of the system operation. NTIS

N93-27488# Universiteit Twente, Enschede (Netherlands). Dept. of Computer Science.

EFFICIENT MODEL-BASED DIAGNOSIS OF DYNAMIC SYSTEMS WITH STATE

M. K. deWeger, R. R. Bakker, and D. J. Out Jun. 1992 41 p Sponsored by Stichting Knowledge Based Systems

(Memo-INF-92-53; UT-KBS-92-29; SKBS-92-15; ETN-93-93207) Copyright Avail: CASI HC A03/MF A01

Model-based diagnosis is a form of knowledge-based diagnosis. Because in model-based diagnosis, knowledge of the structure and the behavior of a system is used, rather than empirical associations between symptoms and diagnoses, it can, in principle, overcome some of the serious limitations of this latter type of diagnosis. Apart from the problem of creating a suitable model, most diagnostics algorithms are limited in their application. Two problems associated with these algorithms are discussed: their inefficiency, and the fact that they can only be applied to static systems. The study describes how some of the limitations of algorithms for model-based diagnosis can be overcome. It is carried out by modifying the General Diagnostic Engine (GDE). An algorithm that can diagnose dynamic systems in polynomial time is obtained. The diagnostic problem is defined for static systems. It is shown how a GDE can be adopted to obtain a new algorithm, the Pragmatic Diagnostic Engine (PDE). It is also shown how PDE can be extended to diagnose combinatorial dynamic systems and applications are given. ESA

N93-27489# Universiteit Twente, Enschede (Netherlands). Dept. of Computer Science.

LEFT-CORNER AND HEAD-CORNER CHART PARSING

Klaas Sikkel and Rieks opdenAkker 1992 31 p

(Memo-INF-92-55; ETN-93-93208) Copyright Avail: CASI HC A03/MF A01

Head-corner parsing of context free grammars is studied as a generalization of left corner parsing. The item based description of predictive chart parsers proved to be a useful formalism for describing such algorithms. Head corner parsing came up in computational linguistics a few years ago, motivated by lingusitic arguments. A more formal analysis, including correctness proofs of the left corner and head corner chart parsers that are designed, is given. When limited to context free grammars, the head-corner parser has a worst case complexity of O(n(exp 5)) time and O(n(exp 4)) space. A simplified version with the usual O(n(exp 3)) time and O(n(exp 2)) space complexity bounds is presented. This allows the linguistically motivated head corner heuristic to be backed up by the worst case complexity of the conventional chart parser. ESA

N93-27491# Universiteit Twente, Enschede (Netherlands). Dept. of Computer Science.

VALIDATION OF STRUCTURE METRICS: A CASE STUDY

K. G. vandenBerg, P. M. vandenBroek, and G. M. vanPetersen Aug. 1992 18 p

(Memo-INF-92-58; ETN-93-93211) Copyright Avail: CASI HC A03/MF A01

A framework for the validation of axiomatic structure metrics is presented. In a case study, the comprehensibility of type expressions in the functional programming language Miranda (trademark) was investigated. A structure metric for the comprehensibility of type expressions was developed together with internal and external axioms. This structure metric was validated experimentally. The calibrated metric function results in a good prediction of the comprehensibility. The results show that statistical analysis is needed to establish the actual order of these software entities and for the calculation of quantities, such as the rank order correlation coefficient and the forecasting efficiency. ESA

N93-27492# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.

ABSTRACTION IN REAL TIME PROCESS ALGEBRA

A. S. Klusener Oct. 1991 35 p Sponsored in part by Commission of the European Communities and Netherlands Organization for Applied Scientific Research

(CWI-CS-R9144; ETN-93-93212) Copyright Avail: CASI HC A03/MF A01

A notion of abstraction in real-time process algebra is proposed. The real-time process algebra, extended by the silent step tau, and the operational semantics are given. A characterizing law of which the soundness and the completeness is proven is found. By adding the integral construct, the symbolic (untimed) process terms can be interpreted as time processes. The resulting tau equivalence is investigated and a delay bisimulation with a stronger root condition is found. The applicability of this notion of real-time abstraction is tested by proving the PAR (Positive Acknowledgement with Retransmission) protocol correct. ESA

N93-27493# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.

AN EXECUTABLE SEMANTICS FOR A SUBSET OF COLD

A. Steven Klusener Oct. 1991 38 p Sponsored by Commission of the European Communities and Netherlands Organization for Applied Scientific Research

(CWI-CS-R9145; ETN-93-93213) Copyright Avail: CASI HC A03/MF A01

In order to develop an interpreter for the specification language COLD, an executable subset of this language referred to as PROTOCOLD is introduced. A semantics for PROTOCOLD is given, which is easier to understand than the relational semantics for the full language COLD. The semantics describes the behavior of the language constructs by inference rules. The starting point is an abstract semantics and the endpoint is a more executable one from which it is only a small step towards a code generator. By studying the semantics presented one can find limitations in the language which may increase the efficiency of the associated interpreter. ESA

N93-27495# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.

SURVEY OF CONTINUITIES OF CURVES AND SURFACES

Remco C. Veltkamp Jan. 1992 31 p Sponsored by Netherlands Organization for Applied Scientific Research

(CWI-CS-R9202; ETN-93-93215) Copyright Avail: CASI HC A03/MF A01

An overview of various types of continuity of curves and surfaces, in particular parametric, visual or geometric, Frenet frame, and tangent surface continuity, is given. The relation with curve and surface modeling, visibility of (dis)continuities, and graphics rendering algorithms, are discussed. The purpose is to provide an overview of types of continuity, and to put many terms and definitions on a common footing in order to give an understanding of the subject. The relation between types of continuity and types of splines as well as Carmull-Rom spline curve and tensor product surface constructions is discussed. The notions of continuity are related to illumination models and shading algorithms for computer graphics rendering, with visual aspects of continuity. ESA

N93-27499# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.

PROCESSES AS TERMS: NON-WELL-FOUNDED MODELS FOR BISIMULATION

J. J. M. M. Rutten Mar. 1992 22 p Submitted for publication Sponsored in part by Commission of the European Communities and Netherlands Organization for Applied Scientific Research

(CWI-CS-R9211; ETN-93-93224) Copyright Avail: CASI HC A03/MF A01

A compositional semantics characterizing bisimulation equivalence is derived from transition system specifications in the Structural Operational Semantics (SOS) style, satisfying certain syntactic conditions. Aczel's nonstandard set theory is used for solving a recursive equation for a domain of processes. It contains non well founded elements modeling possibly infinite behavior. Semantic interpretations of syntactic operators are obtained by defining the operational semantics for terms consisting of both syntactic and semantic (processes) entities. It is possible to return to standard set theory by observing that a similar though less general result can be obtained with the use of complete metric spaces. ESA

N93-27500# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.

PROVABLY RECURSIVE PROGRAMS

R. Tim P. Fernando Mar. 1992 12 p Revised Sponsored by Netherlands Organization for Applied Scientific Research

(CWI-CS-R9212; ETN-93-93225) Copyright Avail: CASI HC A03/MF A01

The relationship between logical notions of computation and of deduction is considered. The 'absoluteness' of the recursion-theoretic notion of computation is contrasted with the 'relative' character of formal proofs. Certain cracks in the correspondence, relativized to a (single) formal theory, between proofs and programs (of bounded complexity) are exposed, and linked to (in-)completeness for Pi(sup zero)(sub 1) sentences. ESA

N93-27501# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.

A PRIMITIVE RECURSIVE SET THEORY AND AFA: ON THE LOGICAL COMPLEXITY OF THE LARGEST BISIMULATION

R. Tim P. Fernando Mar. 1992 18 p Revised Submitted for publication Sponsored by Netherlands Organization for Applied Scientific Research

(CWI-CS-R9213; ETN-93-93226) Copyright Avail: CASI HC A03/MF A01

Computing depends on coding: only what can be coded can be computed. Conversely, constraints on coding determine the sense of, and degree to which what can be coded can be computed. Coding can have greater computational significance, and even a somewhat odd and unlikely use of the notion of a set can sometimes prove fruitful. An instructive example is the set-theoretic coding of (countable) linguistic notions in Kripke-Platek set theory. A subsystem of Kripke-Platek set theory proof theoretically equivalent to primitive recursive arithmetic is isolated; Aczel's (relative) consistency argument for the Anti-Foundation Axiom (AFA), is adapted to a (related) weak setting; and the logical complexity of the largest bisimulation is investigated. ESA

N93-27502# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.

MORE EXAMPLES IN MANIFOLD

I. Herman and F. Arbab May 1992 37 p Sponsored by Netherlands Organization for Applied Scientific Research

(CWI-CS-R9214; ETN-93-93227) Copyright Avail: CASI HC A03/MF A01

An insight into the use of the MANIFOLD system is given. A set of nontrivial examples of programming using the MANIFOLD language is presented. The development of these examples was inspired by some general algorithmic patterns arising in the field of computer graphics and the use of computing forms. A class of adaptive recursive algorithms is described. These algorithms are in widespread use in computer graphics and the MANIFOLD language proved to be appropriate for describing this class of algorithms. An example, usually called a 'computing form' is presented. ESA

N93-27506# Utrecht State Univ. (Netherlands). Dept. of Computer Science.

VIRTUAL DATA STRUCTURES

Doaitse Swierstra and Oege deMoor (Oxford Univ., England.) 23 Apr. 1992 21 p

(Grant NFI-62-518)

(RUU-CS-92-16; ETN-93-93285) Avail: CASI HC A03/MF A01

Techniques which may be used in calculating algorithms for sequence oriented problems are presented. The basic observation underlying this method is that algorithms can be the result of a systematic development, in which all design decisions and applied insights are identified. The class of problems discussed and the concepts necessary to understand the derivations are given. The concept of a virtual data structure, which allows optimization of certain function compositions is presented. ESA

N93-27525# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.

A SIMPLE SPECIFICATION LANGUAGE COMBINING PROCESSES, TIME, AND DATA

Willem Jan Fokkink Feb. 1992 31 p Sponsored in part by Commission

of the European Communities and Netherlands Organization for Applied Scientific Research
(CWI-CS-R9209; ETN-93-93222) Copyright Avail: CASI HC A03/MF A01

The micro Common Representation Language (microCRL) is extended with time, resulting in a language called real-time microCRL (r microCRL). It consists of data, time and processes. The data are defined by declaring sorts and functions working upon these sorts. The meaning of these functions is described by equations. The process part is given in the syntax of Asynchronous Communication Process (ACP). It consists of a set of actions that may be parameterized by data and are provided with a time stamp. There are sequential, alternative and parallel composition, a shift operator and recursive processes. The time domain consists of the floating point numbers, so infinite processes do not exist in real-time microCRL. ESA

N93-27531# Kaman Aerospace Corp., Bloomfield, CT.
DYNAMIC SYSTEM COUPLER PROGRAM (DYSCO 4.1). VOLUME 1: THEORETICAL MANUAL Final Report, 13 Sep. 1985 - 13 May 1988
Alex Berman, Shyi-Yuang Chen, Bruce Gustavson, and Patricia Hurst Jan. 1989 146 p
(Contract DAAJ02-85-C-0033; DA Proj. 1L1-62209-AH-76)
(AD-B131156L; R-1790-14A-Vol-1; USAAVSCOM-TR-88-D-14A-Vol-1)
Avail: CASI HC A07/MF A02

The work performed to enhance the Dynamic System Coupler (DYSCO) computer program through the addition of advanced modeling capabilities is reported. These capabilities include rotor blade damage modeling, Eigen analysis development, general time histories solution development, frequency domain solution development, general modal representation of three-dimensional structures, lifting surface modal representation, landing gear, general force, linear constraints, lifting surface aerodynamics, calculation of component interface and internal loads, and a nonlinear spring and damper system. While the improvements incorporated into DYSCO increase the analytical capabilities of the program, it still has limitations in several areas. More correlation with flight test data or with similar proven analytical tools is needed to validate program results. A new or improved trim algorithm is needed to eliminate deficiencies in the current DYSCO trim algorithm. Also, DYSCO should be converted to double precision to increase the accuracy of program results. Author (revised)

N93-27540# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
ON THE ADEQUACY OF GRAPH REWRITING FOR SIMULATING TERM REWRITING
J. R. Kennaway (East Anglia Univ., Norwich, England.), J. W. Klop (Vrije Univ., Amsterdam, Netherlands.), M. R. Sleep (East Anglia Univ., Norwich, England.), and F.-J. deVries Jan. 1992 21 p Sponsored in part by Commission of the European Communities and Netherlands Organization for Applied Scientific Research
(Grant SERC-GR/F-91582)
(CWI-CS-R9204; ETN-93-93217) Copyright Avail: CASI HC A03/MF A01

A precise analysis of the relationship between cyclic term graph rewriting and infinitary term rewriting, for orthogonal rewrite systems is given. For non-orthogonal systems, graph rewriting and term rewriting differ significantly, although some of our results still hold. Terms and computations of a finite acyclic graph rewriting system can be unravelled into terms and computations of a finitary term rewriting system. An abstract definition of an 'adequate mapping' between abstract reduction systems which captures the properties of the unravelling mapping is presented. It is shown that: finite acyclic graph rewriting is adequate for finite term rewriting; finite graph rewriting is adequate for rational term rewriting; infinite graph rewriting is not adequate for infinite term rewriting. A close correspondence between finitary acyclic graph rewriting and finitary term rewriting, and between finitary cyclic graph rewriting and transfinite rational term rewriting, is established. The correspondence breaks down for general transfinite rewriting. An example showing that transfinite term rewriting is strictly more powerful than transfinite graph rewriting is presented. ESA

N93-27543# National Aerospace Lab., Amsterdam (Netherlands). Informatics Div.
DEFMEF PREDESIGN DOCUMENT
S. deJong 15 Jul. 1991 73 p
(NLR-TP-91269-U; ETN-93-93324) Avail: CASI HC A04/MF A01

Decisive requirements for the DEFMEF language and the associated DEFMEF translator are presented. DEFMEF stands for Design language For MEBAS (Method Base System) and EFFORD (Environment For FORTRAN Development). It is a general purpose design language for software. The basic technical design, which fulfills the requirements, are shown. DEFMEF as a software design language was designed so that it is possible to describe both a technical design and a detailed design with it. The DEFMEF translator generates input for the Computer Aided Software Engineering (CASE) tools, MEBAS, and EFFORD. The thus obtained set of CASE tools, DEFMEF, MEBAS, and EFFORD fulfills a large part of the software engineering process. At the same time, DEFMEF benefits the consistency of the information, used by all three tools. ESA

N93-27551# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
ASYNCHRONOUS COMMUNICATION IN PROCESS ALGEBRA (EXTENDED ABSTRACT)
Frank deBoer (Technische Univ., Eindhoven, Netherlands.), Jan Willem Klop (Vrije Univ., Amsterdam, Netherlands.), and Catuscia Palamidessi (Utrecht State Univ., Netherlands.) Jan. 1992 23 p Sponsored by Netherlands Organization for Applied Scientific Research
(CWI-CS-R9206; ETN-93-93219) Copyright Avail: CASI HC A03/MF A01

The paradigm of asynchronous process communication is studied, as it contrasts with the synchronous communication mechanism which is present in process algebra frameworks such as Calculus of Communicating Systems (CCS), Communicating Sequential Processes (CSP), and ACP (Asynchronous Communication Process). Semantics and axiomatizations with respect to various observability criteria are investigated: bisimulation, traces, and astract traces. The aim is to develop a process theory which can be regarded as a kernel for languages based on asynchronous communication, like data flow, concurrent logic languages, and concurrent constraint programming. ESA

N93-27552# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
COMPUTABLE PROCESSES AND BISIMULATION EQUIVALENCE
Alban Ponse Jan. 1992 31 p Sponsored by Commission of the European Communities and Netherlands Organization for Applied Scientific Research
(CWI-CS-R9207; ETN-93-93220) Copyright Avail: CASI HC A03/MF A01

The property of a transition system being (primitive) recursive is defined. The equivalence relation between transition systems considered is bisimulation. As a means for defining transition systems, the specification language micro Common Representative Language (microCRL) is used. Two simple fragments of microCRL are singled out, yielding universal expressivity with respect to recursive and primitive recursive transition systems over a fixed, finite label set. For all transition systems defined by a microCRL specification over the recursive fragment, and for the class of all primitive recursive transition systems over some finite level set, the properties 'bisimilarity', 'deadlock freedom', and 'regularity' are classified in the arithmetical hierarchy. It is shown that in the domain of primitive recursive transition systems over a fixed, finite label set, a geniune hierarchy in bisimilarity can be defined via the complexity of the witnessing relations. ESA

N93-27553# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
XInPOSSE: STRUCTURAL SIMULATION FOR GRAPHICS HARDWARE
M. A. Guravage, E. H. Blake, and A. A. M. Kuijk Jan. 1992 15 p Sponsored by Netherlands Organization for Applied Scientific Research
(CWI-CS-R9208; ETN-93-93221) Copyright Avail: CASI HC A03/MF A01

A structural simulator is used both to test hardware and to visualize software that should run on the hardware. In a layered set of graphical hardware simulators, a structural simulator bridges the gap between hardware fidelity on the one side and sufficient performance to visualize graphics algorithms on the other. Essential design requirements were coded extensibility and reusability. In order to achieve this, object oriented methods

were adopted. Important design criteria for graphical hardware simulators at this level are that both the exact digital state of the hardware and the graphical output be visualized interactively. The experience with using the XInPosse simulator is presented. XInPosse simulates a large systolic array in custom very large scale integration for second order interpolation; in this case to produce shaded scanlines. XInPosse provides the user with a means of tracing commands within the array while interactively setting breakpoints and displaying processors of particular interest. ESA

N93-27589# Kaman Aerospace Corp., Bloomfield, CT.
DYNAMIC SYSTEM COUPLER PROGRAM (DYSCO 4.1). VOLUME 2: USER'S MANUAL Final Report, 13 Sep. 1985 - 13 May 1988
Alex Berman, Shyi-Yuang Chen, Bruce Gustavson, and Patricia Hurst Jan. 1989 356 p
(Contract DAAJ02-85-C-0033; DA Proj. 1L1-62209-AH-76)
(AD-B131157L; R-1790-14B-Vol-2; USAAVSCOM-TR-88-D-14B-Vol-2)
Avail: CASI HC A16/MF A03

Work performed to enhance the Dynamic System Coupler (DYSCO) computer program through the addition of advanced modeling capabilities is reported. These capabilities include rotor blade damage modeling, Eigen analysis development, general time history solution development, frequency domain solution development, general modal representation of three-dimensional structures, lifting surface modal representation, landing gear, general force, linear constraints, lifting surface aerodyanmics, calculation of component interface and internal loads, and a nonlinear spring and damper system. While the improvements incorporated into DYSCO increase the analytical capabilities of the program, it still has limitations in several areas. More correlation with flight test data or with similar proven analytical tools is needed to validate program results. A new or improved trim algorithm is needed to eliminate deficiencies in the current DYSCO trim algorithm. Also, DYSCO should be converted to double precision to increase the accuracy of program results. Author (revised)

N93-27590# Kaman Aerospace Corp., Bloomfield, CT.
DYNAMIC SYSTEM COUPLER PROGRAM (DYSCO 4.1). VOLUME 3: USER'S MANUAL SUPPLEMENT Final Report, 13 Sep. 1985 - 13 May 1988
Alex Berman, Shyi-Yuang Chen, Bruce Gustavson, and Patricia Hurst Jan. 1989 467 p
(Contract DAAJ02-85-C-0033; DA Proj. 1L1-62209-AH-76)
(AD-B131158L; R-1790-14C-Vol-3; USAAVSCOM-TR-88-D-14C-Vol-3)
Avail: CASI HC A20/MF A04

The work performed to enhance the Dynamic System Coupler (DYSCO) computer program through the addition of advanced modeling capabilities is reported. These capabilities include rotor blade damage modeling, Eigen analysis development, general time history solution development, frequency domain solution development, general modal representation of three-dimensional structures, lifting surface modal representation, landing gear, general force, linear constraints, lifting surface aerodynamics, calculation of component interface and internal loads, and a nonlinear spring and damper system. While the improvements incorporated into DYSCO increase the analytical capabilities of the program, it still has limitations in several areas. More correlation with flight test data or with similar proven analytical tools is needed to validate program results. A new or improved trim algorithm is needed to eliminate deficiencies in the current DYSCO trim algorithm. Also, DYSCO should be converted to double precision to increase the accuracy of program results. Author (revised)

N93-27652# Army Inst. for Research in Management Information and Computer Sciences, Atlanta, GA.
SOFTWARE QUALITY AND TESTING: WHAT DOD CAN LEARN FROM COMMERCIAL PRACTICES Study Report
Mark R. Kindl 31 Aug. 1992 38 p
(AD-A262332; ASQB-GI-92-012) Avail: CASI HC A03/MF A01

With regard to software testing in DoD, we can summarize our conclusions in two fundamental ideas. First, DoD knows how to produce quality software at low cost. This is because organizations such as DoD STEP, Army STEP, and Software Engineering Institute have already researched and documented policies for DoD. A few commercial software developers practice many of the DoD policies and directives now, and produce quality software (for example, IBM FSC Houston). Second, quality cannot be tested into software. Only a well-defined, well-disciplined process with a continuous improvement cycle can ensure software quality. However, testing cannot be underestimated. Systematic testing activities that detect error earliest in the life cycle are necessary to drive process improvement and optimize the development of quality software. Such testing methods as formal inspection find defects early. This enables cost-effective error resolution, identification and removal of defect causes, and thus, prevention of future defect insertion. If practiced with discipline, such methods can evolve a self-correcting software development process that is stable, modeled, measured, and therefore, predictable. This development process engineers quality software faster at reduced cost. DTIC

N93-27665# Institute for Defense Analyses, Alexandria, VA.
AN EXAMINATION OF SELECTED SOFTWARE TESTING TOOLS: Final Report, 1992
Christine Youngblut Dec. 1992 478 p
(Contract MDA903-89-C-0003)
(AD-A261941; AD-E501632; IDA-P-2769; IDA/HQ-92-42571) Avail: CASI HC A21/MF A04

This paper reports on the examination of 27 tools that provide for test management, problem reporting, and static and dynamic analysis of Ada code. It provides software development managers with information that will help them gain an understanding of the current capabilities of tools that are commercially available, the functionality of these tools, and how they can aid the development and support of Ada software. During the course of the examination, the static and dynamic analysis tools were applied to a sample Ada program in order to assess their functionality. The test management and problem reporting tools were also subject to a practical examination using vendor-supplied data. Each tool was then described in terms of its functionality, ease of use, and documentation and support. Problems encountered during the examination and other pertinent observations were also recorded. Available testing tools offer important opportunities for increasing software quality and reducing development and support costs. The wide variety of functionality provided by tools in the same category, however, and, in some cases, lack of tool maturity, require careful tool selection on behalf of a potential user. DTIC

N93-27678# Naval Postgraduate School, Monterey, CA.
A PARALLEL DIVIDE AND CONQUER ALGORITHM FOR THE GENERALIZED REAL SYMMETRIC DEFINITE TRIDIAGONAL EIGENPROBLEM Technical Report, Sep. - Dec. 1992
Carlos F. Borges and William B. Gragg 16 Dec. 1992 23 p
(AD-A262297; NPS-MA-93-009) Avail: CASI HC A03/MF A01

We develop a parallel divide and conquer algorithm, by extension, for the generalized real symmetric definite tridiagonal eigenproblem. The algorithm employs techniques first proposed by Gu and Eisenstat to prevent loss of orthogonality in the computed eigenvectors for the modification algorithm. We examine numerical stability and adapt the insightful error analysis of Gu and Eisenstat to the arrow case. The algorithm incorporates an elegant zero finder with global monotone cubic convergence that has performed well in numerical experiments. A complete set of tested matlab routines implementing the algorithm is available on request from the authors. DTIC

N93-27852# Rex, Thompson and Partners, Farnham (England).
USER GUIDE TO FTSCORE: A REPLACEMENT PROGRAM FOR SCORE IN THE TANKILL SUITE OF VULNERABILITY ASSESSMENT PROGRAMS
D. J. Mason and R. E. Cooke Nov. 1983 76 p
(Contract FVE-13b/381)
(RTP/2180/01; BR90327; ETN-93-93782) Copyright Avail: CASI HC A05/MF A01

The program FTSCORE was developed as an alternative to the program SCORE in the TANKILL suite of vulnerability assessment programs. The program FTSCORE uses fault trees to relate component states to explicitly defined functional states (or 'degradation modes') of the target as a whole. The fault tree technique, which has been used for some time in the reliability field, has only recently been applied to lethality and vulnerability studies. It is considered to be an improvement over the MFK (Mobility, Firepower, catastrophic Kill indexing) approach because it formalizes the analysis in a more systematic, quantitative, and flexible fashion. This document is a user's guide to the program FTSCORE, and it describes

the scope and application of the program. It provides sufficient information to run the program in a vulnerability assessment of an armored fighting vehicle. ESA

N93-27874# Technische Univ., Delft (Netherlands).
THE IDENTIFICATION OF ANALYTICAL DEVICE MODELS Ph.D. Thesis
Martin Guido Middelhoek 1992 139 p Sponsored by Stichting voor Fundamenteel Onderzoek, Netherlands
(ISBN-90-6275-764-2/CIP; ETN-93-93600) Copyright Avail: CASI HC A07/MF A02

A unified approach to the identification of analytical device models is presented. The identification methods considered are all based on data fitting techniques; the model parameters are determined by optimizing an identification criterion that expresses the difference between the observed device behavior and the device behavior that is predicted by the model. The choice of the identification criterion is based on assumptions about the characteristics of the model and the observation errors. Hence, the acceptability of an identification method depends on how realistic these assumptions are when applied to practical identification problems. A data fitting method for the identification of analytical device models, that takes into account the limited validity domain of these models, is proposed: MODES (Mode Selection). Disussion of the algorithm focuses on the underlying principles. Although the discussion is limited to electronic device model identification, the application has a much wider field. ESA

N93-27885# Nijmegen Univ. (Netherlands). Dept. of Informatics.
GWB: MANUAL FOR THE GRAMMAR WORK BENCH, VERSION 1.0
C. Dekkers, C. H. A. Koster, M.-J. Nederhof, and A. vanZwol Dec. 1991 13 p
(TR-91-28; ETN-93-93138) Avail: CASI HC A03/MF A01

The manual of the Grammar Work Bench (GWB) is presented. The GWB is an environment for the comfortable development of Affix Grammars over a Finite Lattice (AGFL) formalism. Its purposes are as follows: to allow the user to input, inspect, and modify a grammar; to perform consistency checks on a grammar; to compute grammar properties; to generate example sentences; to assist in performing grammar transformations. The GWB is not a computer game. Its user interface is not supposed to be self explanatory but the user is supposed to have read this manual and in particular to know the commands. Use of the GWB to work with an existing grammar or to compose a new grammar is described. The commands, the GWB editor, and the semantic checks are outlined, and a description of AGFL is given. ESA

N93-27902# Nijmegen Univ. (Netherlands). Dept. of Informatics.
THE GRAMMAR WORKBENCH: A FIRST STEP TOWARDS LINGWARE ENGINEERING
Mark-Jan Nederhof, Cornelis H. A. Koster, Christ Dekkers, and Arend vanZwol Feb. 1992 14 p Presented at the Twente Workshop on Language Technology 2, Enschede, Netherlands, 20 Nov. 1991 Submitted for publication
(Grant NWO-00-62-518)
(TR-92-06; ETN-93-93141) Avail: CASI HC A03/MF A01

The ideas behind the Grammar Workbench (GWB) are described. The GWB is one of a series of tools for the development of AGFLs (Affix Grammars over a Finite Lattice) for natural language. Its functions comprise a specialized editor, computation of properties, and special output routines to provide an overview of a grammar. AGFLs, the AGFL project, the functions of the GWB, and some aspects of incremental computation as applied in the GWB, are discussed. ESA

N93-27908# Utrecht State Univ. (Netherlands). Dept. of Computer Science.
THE POWER OF PARALLEL PROJECTION
Marc vanKreveld Apr. 1992 18 p Sponsored by EEC/ESPRIT
(RUU-CS-92-17; ETN-93-93286) Avail: CASI HC A03/MF A01

Using a basic lemma in parallel projections, it is shown that k-flat searching can be reduced to a 'combination' of d searhes in (k + 1) dimensional space. This search is performed with k-flats, thus hyperplanes. Two basic lemmas on projections are further presented. Thus, it is shown that from d projections of a k-flat into k-dimensional linear subspaces, the k-flat can still be constructed. Futhermore, a k-flat and a j-flat are shown to intersect in d-space if and only if they intersect in (d over k + j + 1) linear subspaces of dimension (k + j + 1) (and which are independent of the k-flat and the j-flat). Applications of these projection results are k-dimensional simplex searching for a set S of n points in d-dimensional space with a structure of size O(n(sup(k + 1 + epsilon))) and O(log n) query time, for arbitrarily small positive epsilon. A second application is ray shooting in axis-parallel boxes in d-dimensional space, with a structure of size O(n(sup(2 + epsilon))) and O(log n) query time. A structure for k-flat intersection searching in a set of j-flats is also obtained. ESA

N93-27920# Carnegie-Mellon Univ., Pittsburgh, PA. School of Computer Science.
CONSISTENCY MANAGEMENT FOR VIRTUALLY INDEXED CACHES
Bob Wheeler and Brian N. Bershad Oct. 1992 15 p
(Contract MDA972-90-C-0035; ARPA Order 7330)
(AD-A261952; CMU-CS-92-182) Avail: CASI HC A03/MF A01

A virtually indexed cache can improve performance by allowing cache lookup and address translation to occur in parallel, thus reducing processor cycle time. Unlike physically indexed caches, virtually indexed caches create consistency problems because a physical address may be represented in more than one cache line when it has been accessed through more than one virtual address. Write-back virtually indexed caches create additional inconsistencies because memory may become stale with respect to the cache. In this paper we examine the problem of consistency management for a virtually indexed write-back cache. We assume that the hardware does not support intra-cache consistency. We present a model and software implementation strategy for maintaining consistency with virtually indexed caches. We present measurements from an implementation of this model on the HP in the context of the Mach operating system. Our measurements show that a virtually indexed cache can be managed with nearly the same cost as that required to manage a physically indexed one, even when used by a virtual memory system that encourages and exploits sharing. DTIC

N93-27947# Alenia Aeronautica, Naples (Italy). Direzione Aree Tecniche.
AUTOMATIZATION OF STRUCTURAL ANALYSIS CALCULATION PROCEDURE: NASTRAN PRE AND POST PROCESSORS [L'AUTOMAZIONE DELLE PROCEDURE DI CALCOLO NELL'ANALISI STRUTTURALE: I PRE E POST PROCESSORS NASTRAN]
G. deMita 1991 68 p In ITALIAN
(ETN-93-93706) Avail: CASI HC A04/MF A01

General characteristics of the NASTRAN structural analysis code pre and post processors are illustrated. The creation and control of the Finite Element Method (FEM) model are described. The graphical visualization of analysis results and the verification of the structure as a whole are described. Examples of the output graphics from the program subroutines are supplied. ESA

N93-27994# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
ORIGIN TRACKING
A. vanDeursen, P. Klint, and F. Tip Jul. 1992 51 p Sponsored in part by EEC, and Netherlands Organization for Scientific Research
(CWI-CS-R9230; ETN-93-93828) Copyright Avail: CASI HC A04/MF A01

The notion of an 'origin' is introduced in the framework of conditional, not necessarily orthogonal, term rewriting systems. Origins are relations between subterms of intermediate terms which occur during rewriting, and subterms of the initial term. Original tracking is a method for incrementally computing origins during rewriting. Origins are a generalization of the well known concept of residuals (also called descendants). A formal definition of origins is given and a method for implementing them is presented. Origin tracking is a highly versatile technique when applied to the prototyping of algebraic specifications of programing languages. For example, origin tracking allows program execution to be visualized in a semi-automatic way, given an algebraic specification of the dynamic semantics of the programming language. Furthermore, various notions of breakpoints for generic debuggers can be defined without difficulty. Given a specification of the static semantics of a programming language, origin tracking enables, once an error (such as type-incompatability) has been detected, the position of the error in the source program to be inferred automatically. ESA

N93-27995# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
REGULAR PROCESSES WITH RELATIVE TIME AND SILENT STEPS
Willem Jan Fokkink Jul. 1992 24 p Sponsored by EEC
(CWI-CS-R9231; ETN-93-93829) Copyright Avail: CASI HC A03/MF A01

A study in which recursion is added to real time process algebra is presented. An elimination theorem and a completeness result are proven for regular processes, where the time domain is restricted to the rational numbers. The alphabet is extended with the silent step tau and completeness is deduced for regular processes with relations to rooted branching bisimulation. ESA

N93-27996# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
A BRIEF SURVEY OF ZERO-KNOWLEDGE PROOFS
Hyunyong Shin Aug. 1992 14 p Submitted for publication Sponsored in part by Netherlands Organization for Scientific Research, and Science and Engineering Foundation, Korea
(CWI-CS-R9232; ETN-93-93830) Copyright Avail: CASI HC A03/MF A01

The zero knowledge proofs in the literature are reviewed. The notion of zero knowledge is important in cryptography and is also related to complexity theory. The (interactive) proof systems addressed are: for languages; for decision problems; of knowledge; of computational power; multi-prover; instance hiding; with space bounded variables; and noninteractive. ESA

N93-27997# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
SPECIFICATION AND GENERATION OF A LAMBDA-CALCULUS ENVIRONMENT
Arie vanDeursen Aug. 1992 20 p Sponsored in part by EEC, and Netherlands Organization for Scientific Research
(CWI-CS-R9233; ETN-93-93831) Copyright Avail: CASI HC A03/MF A01

An algebraic specification of the lambda calculus is described. The specification covers valid substitutions; alpha, beta, and eta conversions; left-most reductions; and let-constructs for lambda definitions. The complete specification of the lambda calculus is given. By deriving parsers from signatures, and term rewriting systems from equations, tools are generated automatically from the specification. Combining these tools by means of a user interface description formalism, an environment for experimenting with the lambda calculus was generated. The environment obtained in this way is presented. ESA

N93-28001# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
DYNAMIC MODAL PREDICATE LOGIC
D. Jan N. vanEijck (OTS, Utrecht, Netherlands.) and Giovanna Cepparello (Scuola Normale Superiore, Pisa, Italy.) Sep. 1992 22 p Sponsored by Netherlands Organization for Scientific Research
(CWI-CS-R9237; ETN-93-93835) Copyright Avail: CASI HC A03/MF A01

A combination of dynamic predicate logic and update logic is presented in the form of a dynamic version of Modal Predicate Logic (DMPL). This logic is shown to be eliminative at a global level and distributive at a local level. The logic is axiomatized in Quantified Dynamic Modal Logic (QDML). The axiomatization gives rise to a translation function from quantified dynamic modal logic to modal predicate logic. This translation function can be used to compute the conditions for success of DMPL programs, that is to derive the static truth conditions of DMPL meaning representations. ESA

N93-28012# Universiteit Twente, Enschede (Netherlands). Dept. of Applied Mathematics.
AN ALGORITHM FOR DETERMINING THE APPROXIMATION ORDERS OF MULTIVARIATE PERIODIC SPLINE SPACES
Ruud vanDamme Aug. 1992 14 p
(MEMO-1061; ETN-93-93843) Avail: CASI HC A03/MF A01

An algorithm which computes the approximation order of spaces of periodic piecewise polynomial functions, given the degree, the smoothness, and tessalation, is given. The algorithm consists of two steps. The first gives an upper bound and the second a lower bound in the approximation order. In all known cases the two bounds coincide. ESA

N93-28062# Utrecht State Univ. (Netherlands). Dept. of Computer Science.
THE LAZYRMS: AVOIDING WORK IN THE ATMS
Gerry Kelleher and Linda vanderGaag May 1992 20 p
(RUU-CS-92-20; ETN-93-93289) Avail: CASI HC A03/MF A01

The basic algorithms involved in reason maintenance in the standard ATMS (Assumption based Truth Maintenance System) are known to have a computational complexity that is exponential in the worst case. Yet, also in average case problem solving, the ATMS often lays claim to a major part of the computational effort spent by a problem solver/ATMS system. An argument is proposed that, within the limits of the worst case computational complexity, it is possible to improve on the average case complexity of reason maintenance and query processing by eliminating computation that is of no relevance to the problem solver's performance. To this purpose, a set of algorithms designed to control the effort spent by the ATMS on label updating is presented. The basic idea underlying these algorithms is that of lazy evaluation: labels are not automatically contained on all datums but are computed only when needed (either directly or indirectly) by the problem solver. The algorithms were implemented in the LazyRMS experimented within the context of model based diagnosis; experiments show a substantial saving in the computational effort spent in reason maintenance. ESA

N93-28066# Groningen Rijksuniv. (Netherlands). Computing Science Section.
CONCURRENT DATA OBJECTS IN QUADRATIC SPACE
Wim H. Hesselink Dec. 1991 22 p
(CS-9112; ETN-93-93325) Avail: CASI HC A03/MF A01

For an arbitary data object, a wait-free, linearizable concurrent implementation is presented with space complexity quadratic in the number of processes. The correctness, especially of the memory reallocation, is argued by means of stable predicates. The construction is based on a 'compare and swap' register. The time complexity is linear in the number of processes. A variation of the algorithm is presented that does not need a 'compare and swap' register but requires unbounded integers. This variation has the same space complexity, but quadratic time complexity. ESA

N93-28086# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Analysis, Algebra and Geometry.
ON ZEILBERGER'S ALGORITHM AND ITS Q-ANALOGUE: A RIGOROUS DESCRIPTION
Tom H. Koornwinder (Amsterdam Univ., Netherlands.) Jun. 1992 24 p
(CWI-AM-R9207; ETN-93-93816) Copyright Avail: CASI HC A03/MF A01

Algorithms for summation of terminating hypergeometric series as well as the q versions of these algorithms are described in a very rigorous way. The study is a companion to Maple 5 procedures implementing these algorithms. It concludes with the help information for these procedures. ESA

N93-28093# Utrecht State Univ. (Netherlands). Dept. of Computer Science.
TREEWIDTH AND PATHWIDTH OF PERMUTATION GRAPHS
H. Bodlaender, T. Kloks, and D. Kratsch (Friedrich-Schiller Univ., Jena, German D.R..) Sep. 1992 18 p Sponsored by Netherlands Foundation for Computer Science
(RUU-CS-92-30; ETN-93-93862) Avail: CASI HC A03/MF A01

It is shown that the treewidth and pathwidth of a permutation graph can be computed in polynomial time. In fact, for permutation graphs, the treewidth and pathwidth are shown to be equal. These results make permutation graphs one of the few nontrivial graph classes for which, at the moment, treewidth is known to be computable in polynomial time. The algorithm to decide whether the treewidth (pathwidth) is at most some given integer k can be implemented to run in O(n(k squared)) time when the matching diagram is given. This algorithm is shown to be easily adaptable to compute the treewidth of a permutation graph in O(n(k squared)) time where k is the treewidth. ESA

N93-28102# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
AN ARCHITECTURE FOR INTERACTIVE RASTER GRAPHICS
A. A. M. Kuijk, E. H. Blake, and P. J. W. tenHagen Jul. 1992 14 p
(CWI-CS-R9229; ETN-93-93827) Copyright Avail: CASI HC A03/MF A01

A radical reappraisal of the three dimensional (3-D) interactive graphics pipeline has resulted in an experimental architecture for a workstation which is currently being evaluated. The principle features of this architecture are that it: concentrates exclusively on real time interactive 3-D graphics (initially for Computer Aided Design); uses object space rather than image space methods where possible; avoids using a frame buffer; only uses custom VLSI (Very Large Scale Integration) where commercial products are unlikely to suffice in the near term. Four years into the project the system design is complete and the major components have been acquired and the custom VLSI chips have been packaged and tested. The current experience with the system is based on detailed simulations which gave a fairly clear idea on its strengths and limitations. A complete, but reduced resolution, experimental prototype system is now being assembled. ESA

N93-28103# Utrecht State Univ. (Netherlands). Dept. of Computer Science.
A LINEAR TIME ALGORITHM FOR FINDING TREE-DECOMPOSITIONS OF SMALL TREEWIDTH
Hans L. Bodlaender Sep. 1992 18 p
(RUU-CS-92-27; ETN-93-93859) Avail: CASI HC A03/MF A01

A linear time algorithm for constant k is presented, that given a graph G = (V, E), determines whether the treewidth of G is at most k, and if so, finds a tree decomposition of G with treewidth at most k. A consequence is that every minor closed class of graphs that does not contain all planar graphs has a linear time recognition algorithm. ESA

N93-28104# Utrecht State Univ. (Netherlands). Dept. of Computer Science.
TREEWIDTH OF CHORDAL BIPARTITE GRAPHS
T. Kloks and D. Kratsch (Friedrich-Schiller Univ., Jena, German D.R..) Sep. 1992 17 p Sponsored in part by Netherlands Foundation for Computer Science
(RUU-CS-92-28; ETN-93-93860) Avail: CASI HC A03/MF A01

Cordal bipartite graphs are exactly those bipartite graphs in which every cycle of length at least six has a chord. The treewidth of a graph G is the smallest maximum cliquesize among all chordal supergraphs of G decreased by one. A polynomial time algorithm for the exact computation of the treewidth of all chordal bipartite graphs is presented. ESA

N93-28105# Utrecht State Univ. (Netherlands). Dept. of Computer Science.
APPROXIMATING TREEWIDTH AND PATHWIDTH OF SOME CLASSES OF PERFECT GRAPHS
T. Kloks and H. Bodlaender Sep. 1992 21 p Sponsored by Netherlands Foundation for Computer Research
(RUU-CS-92-29; ETN-93-93861) Avail: CASI HC A03/MF A01

The problem of finding approximations for the treewidth and pathwidth of cotriangulated graphs, convex graphs, permutation graphs and of cocomparability graphs, is discussed. For a cotriangulated graph, of which the treewidth is at most k, the pathwidth is at most 3k + 4 and an O(n squared) algorithm finding a path decomposition with width at most 3k + 4 is shown to exist. For convex graphs with treewidth at most k, the pathwidth is at most 2k + 1 and an O(nk) algorithm which computes a path decomposition with width at most 2k + 1 is given. If G(pi) is a permutation graph with treewidth k, then it is shown that the pathwidth of G(pi) is at most 2k, and an algorithm which constructs a path decomposition with width at most 2k in time O(nk) is given. The permutation pi is assumed to be given. The problem of finding an approximation for the treewidth and pathwidth of cocomparability graph is discussed. If the treewidth of a cocomparability graph is at most k, then the pathwidth is shown to be most O(k squared) and a simple algorithm finding a path decomposition with this width is given. The running time of the algorithm is dominated by a coloring algorithm of the graph. Such a coloring can be found in time O(n cubed). If the treewidth is bounded by some constant, these results, together with previous results, show that, once the approximations are given, the exact treewidth and pathwidth can be computed in linear time for all these graphs. ESA

N93-28106# Utrecht State Univ. (Netherlands). Dept. of Computer Science.
THE COMPLEXITY OF THE FREE SPACE FOR MOTION PLANNING AMIDST FAT OBSTACLES
A. vanderStrappen Oct. 1992 27 p Sponsored in part by Netherlands Organization for Scientific Research, and EEC
(RUU-CS-92-31; ETN-93-93863) Avail: CASI HC A03/MF A01

The complexity of motion planning algorithms highly depends on the complexity of the robot's free space, that is, the set of all collision free placements of the robot. Theoretically, the complexity of the free space can be very high, resulting in bad worst case time bounds for motion planning algorithms. In practice, the complexity of the free space tends to be much smaller than the worst case complexity. Motion planning algorithms with a running time that is determined by the complexity of the free space therefore become feasible in practical situations. It is shown that under some realistic assumptions, the complexity of the free space of a robot with any fixed number of degrees of freedom moving around in a d dimensional Euclidean workspace with fat obstacles is linear in the number of obstacles. The complexity results lead to highly coefficient algorithms for motion planning amongst fat obstacles. ESA

N93-28108# Utrecht State Univ. (Netherlands). Dept. of Computer Science.
DRAWING PLANAR GRAPHS USING THE lmc-ORDERING
Goos Kant Oct. 1992 44 p
(RUU-CS-92-33; ETN-93-93865) Avail: CASI HC A03/MF A01

A method to optimize the required area, minimum angle and number of bends of planar drawings of graphs on a grid, is presented. The main tool is a new type of ordering on the vertices and faces of triconnected planar graphs. With this method linear time and space algorithms can be designed for many graph drawing problems. The results give in some cases considerable improvements over previous results, and give new bounds in other cases. Several other results, for example concerning visibility representations, are included. ESA

N93-28118# Carnegie-Mellon Univ., Pittsburgh, PA. Dept. of Computer Science.
THE SECOND GARNET COMPENDIUM: COLLECTED PAPERS 1990-1992 Technical Report
Brad A. Myers Feb. 1993 139 p
(Contract F33615-90-C-1465; ARPA Order 7597)
(AD-A262696; CMU/CS-93-108) Avail: CASI HC A07/MF A02

The Garnet User Interface Development Environment contains a comprehensive set of tools that make it significantly easier to design and implement highly-interactive, graphical, direct manipulation user interfaces. This technical report brings together nine papers about various aspects of the Garnet project. It is a sequel to Computer Science Technical Report CMU-CS-90-154 which contained articles about Garnet from 1989-1990. DTIC

N93-28165# Utrecht State Univ. (Netherlands). Dept. of Computer Science.
TOWARDS THE FORMAL DESIGN OF SELF-STABILIZING DISTRIBUTED ALGORITHMS
P. J. A. Lentfert and S. D. Swierstra Aug. 1992 27 p
(RUU-CS-92-25; ETN-93-93857) Avail: CASI HC A03/MF A01

Self-stabilizing algorithms are distributed algorithms which do not depend on a specific initial state of the system. Once started, a self stabilizing system is guaranteed to reach a legitimate state, even in the presence of certain faults. The fault tolerant behavior makes self stabilizing very interesting. However, self-stabilizing algorithms are usually highly complex. To ensure correctness, a formal proof must be given. The two new logical operators in UNITY are introduced. A description of how these operators can be used to formally specify the problem which a self-stabilizing algorithm is assumed to solve is presented. A general scheme to specify self-stabilizing distributed algorithms, provided that there are no circular dependencies between different variables, is presented. This is illustrated by designing a distributed self-stabilizing algorithm for maintaining the maximum value of a possibly changing bag of integers. ESA

N93-28182# Naval Air Warfare Center, Warminster, PA. Mission Avionics Technology Dept.
MACRO FUNCTION LANGUAGE HARDWARE MANUAL Final Report
Timothy Monaghan and Robert Peck Oct. 1992 64 p
(AD-A262109; NAWCADWAR-92100-50) Avail: CASI HC A04/MF A01

This report examines the hardware interface required for an efficient implementation of the Macro Function Language (MFL). Traditionally, computer systems were developed by designing hardware, then writing microcode, assembly language, and on up to a common programing language such as Ada or PASCAL. This emphasis on hardware was due to the relative high cost of hardware. In the current state of the art, software costs are far greater than hardware over the life of a signal processor. Because of this, the MFL attempts to standardize the software interface to hardware. This interface will standardize the software between signal processors designed to run MFL down to the microcode level. DTIC

N93-28204# Oesterreichisches Forschungszentrum Seibersdorf G.m.b.H., Vienna.
GENERIC APPLICATION LAYER FOR PC-CONTROLLED VME MEASURING SYSTEMS (GAL PC-VME) [GENERIC APPLICATION LAYER FUER PC-BEDIENTE VME-MESSSYSTEME (GAL PC-VME)]
Bernhard Strobl and Karl Novogoratz May 1992 62 p In GERMAN
(OEFZS-4630; ETN-93-93451) Copyright Avail: CASI HC A04/MF A01

A GAL was developed for communication between a PC and VME. Highly reliable VME-bus components were developed as data acquisition systems for environmental data. The visualization of the collected data and the control of the system are implemented with a cheap (and less reliable) PC (Personal Computer). The communication between the two components, PC and VME (a Motorola Versabus-like product based on Eurocard) is the subject of the GAL development. A model was created which classifies the incoming (collected) data. Access methods for each class (application layer) and according PASCAL algorithms were constructed. To be flexible in type and quantity of data, source code for VME and PC was produced in a generic manner from a textual description language. Whereas the user interface on the PC is generated completely, a specific VME task has to be user written for each independent component. ESA

N93-28214# Stanford Univ., CA. Dept. of Operations Research.
NEW APPROACHES TO LINEAR AND NONLINEAR PROGRAMMING
Walter Murray and Michael A. Saunders Feb. 1993 4 p
(Contract DE-FG03-92ER-25117)
(DE93-010134; DOE/ER-25117/T1) Avail: CASI HC A01/MF A01

This program involves study of theoretical properties and computational performance of algorithms that solve linear and nonlinear programs. Emphasis is placed on algorithms to solve large problems, especially in the energy area. The safe, efficient distribution of electricity and the identification of the state of an electrical network are both large-scale nonlinearly constrained optimization problems. Other applications include optimal trajectory calculations and optimal structural design. DOE

N93-28220# Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
FEATURE MODELLING AND CONVERSION: KEY CONCEPTS TO CONCURRENT ENGINEERING
Willem F. Bronsvoort and Frederik W. Jansen 1992 41 p
(Rept-92-44; ETN-93-93134) Copyright Avail: CASI HC A03/MF A01

Feature modeling, a relatively new development in CAD/CAM (Computer Aided Design/Manufacturing), is addressed. Whereas in solid modeling only information about the geometry of products is stored, in feature modeling functional information is also stored in the product model. An overview of the main concepts in feature modeling is presented, and issues in feature modeling that are relevant for further research are indicated. There is much confusion about what features actually are, and therefore definitions, classifications, and examples of features are given. Because feature modeling builds on solid modeling, an overview of advanced solid modeling is given, with emphasis on the concepts of parametric and constraint based modeling. Attention is next focused on represention of features. The two most important ways to define features in a product model, feature recognition from a geometric model and design by features, are then discussed. Design by features is illustrated by the GeoNode system. One of the main themes of the presentation is that for different applications, different features are required, and therefore there is a need for automatic conversion between features. Such conversion is of particular importance for the support of concurrent engineering, in which several engineers from different disciplines work simultaneously on the design of a product. ESA

N93-28221# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
FASTER PHONG SHADING
E. H. Blake, V. C. J. Disselkoen, and A. A. M. Kuijk Jul. 1992 19 p
(CWI-CS-R9228; ETN-93-93826) Copyright Avail: CASI HC A03/MF A01

Phong shading is a very well known shading algorithm for producing realistic images. Real time Phong shading has on the whole remained too expensive for hardware implementations, either because of excessive computational complexity or because of large storage requirements. An algorithm designed to produce Phong shaded pixels with the small incremental cost using the least storage possible is presented. Its incremental pixel cost is 5 additions with 3 registers to store and accumulate forward differences. This method is well suited to fast hardware implementations, but, because of its accuracy and extensibility, it is also an attractive software solution. A quadratic expression based on angular interpolation for Phong shading is derived which involves neither further approximations beyond those implicit in the Phong model for vector interpolation nor table lookup for exponent evaluation. These benefits are paid for by increased polygon and scanline preprocessing compared to earlier methods. The method can deal with the case where the viewer and light source are inside the scene, that is, when the light or viewer direction varies over the shaded surface. Extensions deal with pixel integration anti-aliasing and these require cubic rather than quadratic interpolation. A detailed analysis of the costs and benefits of the method and previous methods of optimizing or approximating the Phong shading algorithm is given. ESA

N93-28231# Pennsylvania State Univ., University Park. Dept. of Computer Science.
SPARSE MATRIX ALGORITHMS ON DISTRIBUTED MEMORY MULTIPROCESSORS
A. Pothen 1993 5 p
(Contract DE-FG02-91ER-25095)
(DE93-009368; DOE/ER-25095/2) Avail: CASI HC A01/MF A01

Progress was made in creating algorithms and software for large-scale sparse matrix computations on advanced distributed-memory parallel machines during the past year. This report is divided into the following: large-scale linear systems; highly parallel triangular solution; spectral nested dissection orderings; parallel multifrontal factorization; structure of orthogonal factors; and sparse bases for the range space and the null space. DOE

N93-28239# Illinois Univ., Urbana.
AN INTEGRATED ENVIRONMENT FOR THE DEVELOPMENT OF SCIENTIFIC AND ENGINEERING APPLICATIONS Final Report, 1 Dec. 1989 - 30 Nov. 1992
David J. Kuck 1992 31 p
(Grant AF-AFOSR-0044-90)
(AD-A262277; AFOSR-93-0173TR) Avail: CASI HC A03/MF A01

A new environment has been provided to assist in the programming of high performance parallel and vector computers. The environment consists of a unified set of programming tools such as restructuring compilers, parallel debuggers, performance evaluation tools, and data visualization tools. This design takes into consideration the entire process of scientific/engineering project development. DTIC

N93-28240# Naval Command, Control and Ocean Surveillance Center, San Diego, CA. Research, Development, Test and Evaluation Div.
IMPROVEMENTS TO THE HIGH-FREQUENCY BENCHMARK PROPAGATION ANALYSIS PROGRAM Final Report
J. A. Ferguson Jan. 1993 22 p
(AD-A262278; NCCOSC/RDT/E-TD-2411) Avail: CASI HC A03/MF A01

The High-Frequency Benchmark is a computer code being developed to employ a sophisticated ray tracing program coupled with a state-of-the-art ionospheric model of the user's choice. The merging of these two major components depends critically on the development of a spatial smoothing routine that accepts arbitrary ionospheric models as input. Such a spatial

smoothing routine was developed and implemented in the benchmark. This report describes improvements and enhancements to that computer program. DTIC

N93-28291# Calspan-Buffalo Univ. Research Center, NY.
CONSTRAINTS LOGIC PROGRAMMING IN KNOWLEDGE-BASED PLANNING DOMAINS Final Report, Jun. - Jul. 1992
William B. Day Dec. 1992 37 p
(Contract F30602-88-D-0026)
(AD-A262958; RL-TR-92-297) Avail: CASI HC A03/MF A01

This report describes an investigation of constraint logic programming languages and their application to knowledge-based planning systems. An overview of constraint logic programming (CLP) languages is presented with specific attention to CLP(R), a Prolog based CLP language. Two planning/scheduling systems are presented and features identified as potential sources of CLP(R) improvements. Finally, two examples are presented. DTIC

N93-28299# Los Alamos National Lab., NM.
THE MONTE CARLO/S(SUB N) HYBRID METHOD WITH ORTHOGONAL INTERFACE BASIS VECTORS
W. L. Filippone (Arizona Univ., Tucson.), R. S. Baker, and R. E. Alcouffe 1992 15 p Presented at the International Topical Meeting on Mathematical Methods and Supercomputing in Nuclear Applications (M/C+SNA 1993), Karlsruhe, Germany, 19-23 Apr. 1993
(Contract W-7405-eng-36)
(DE93-005462; LA-UR-92-4363; CONF-930404-3) Avail: CASI HC A03/MF A01

The memory requirements of the Monte Carlo/S(sub N) hybrid method are large due to the need to store the Monte Carlo response matrix. This response matrix is used repeatedly during the iterative solution for the interface flux vectors. Although the length of these vectors can be large (depending on the number of discretized states on the Monte Carlo/S(sub N) interface), we have found that to an excellent approximation they can be expressed in terms of a small number of basis vectors. Representing the response matrix in terms of the basis vectors, we are able to greatly reduce storage requirements, and to use direct inversion to estimate the converged interface fluxes. DOE

N93-28316# Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
EQUIVALENCE OF A NUMBER OF DEDUCTION SYSTEMS [EQUIVALENTIE VAN EEN AANTAL DEDUCTIESYSTEMEN]
H. deNivelle 1992 73 p In DUTCH
(Rept-92-34; ETN-93-93126) Copyright Avail: CASI HC A04/MF A01

A number of deduction systems are treated. The deduction systems are very accurately defined: the natural deduction system of Fitch, an axiomatic method, and a Gentzen sequence calculus. The accurate definition allows the implementation of the deduction systems in a computer program. Some properties of the substitution operator are very difficult to prove, e.g. several exchange properties. Therefore, a method (the so called Var terms) is introduced to facilitate this task. ESA

N93-28319*# Research Inst. for Computing and Information Systems, Houston, TX.
REPOSITORY-BASED SOFTWARE ENGINEERING PROGRAM: WORKING PROGRAM MANAGEMENT PLAN
15 Apr. 1993 28 p Prepared in cooperation with Applied Expertise, Inc., Houston, TX
(Contract NCC9-16; RICIS Proj. RB-04)
(NASA-CR-193113; NAS 1.26:193113) Avail: CASI HC A03/MF A01

Repository-Based Software Engineering Program (RBSE) is a National Aeronautics and Space Administration (NASA) sponsored program dedicated to introducing and supporting common, effective approaches to software engineering practices. The process of conceiving, designing, building, and maintaining software systems by using existing software assets that are stored in a specialized operational reuse library or repository, accessible to system designers, is the foundation of the program. In addition to operating a software repository, RBSE promotes (1) software engineering technology transfer, (2) academic and instructional support of reuse programs, (3) the use of common software engineering standards and practices, (4) software reuse technology research, and (5) interoperability between reuse libraries. This Program Management Plan (PMP) is intended to communicate program goals and objectives, describe major work areas, and define a management report and control process. This process will assist the Program Manager, University of Houston at Clear Lake (UHCL) in tracking work progress and describing major program activities to NASA management. The goal of this PMP is to make managing the RBSE program a relatively easy process that improves the work of all team members. The PMP describes work areas addressed and work efforts being accomplished by the program; however, it is not intended as a complete description of the program. Its focus is on providing management tools and management processes for monitoring, evaluating, and administering the program; and it includes schedules for charting milestones and deliveries of program products. The PMP was developed by soliciting and obtaining guidance from appropriate program participants, analyzing program management guidance, and reviewing related program management documents. Author (revised)

N93-28320*# Research Inst. for Computing and Information Systems, Houston, TX.
THE THEORY OF INTERFACE SLICING
Jon Beck (West Virginia Univ., Morgantown.) 1 May 1993 48 p
(Contract NCC9-16; RICIS Proj. RB-10)
(NASA-CR-193108; NAS 1.26:193108) Avail: CASI HC A03/MF A01

Interface slicing is a new tool which was developed to facilitate reuse-based software engineering, by addressing the following problems, needs, and issues: (1) size of systems incorporating reused modules; (2) knowledge requirements for program modification; (3) program understanding for reverse engineering; (4) module granularity and domain management; and (5) time and space complexity of conventional slicing. The definition of a form of static program analysis called interface slicing is addressed. Derived from text

N93-28328*# Research Inst. for Computing and Information Systems, Houston, TX.
THE REPOSITORY-BASED SOFTWARE ENGINEERING PROGRAM: REDEFINING AdaNET AS A MAINSTREAM NASA SOURCE
9 Feb. 1993 18 p Prepared in cooperation with Applied Expertise, Inc., Houston, TX
(Contract NCC9-16)
(NASA-CR-193114; NAS 1.26:193114) Avail: CASI HC A03/MF A01

The Repository-based Software Engineering Program (RBSE) is described to inform and update senior NASA managers about the program. Background and historical perspective on software reuse and RBSE for NASA managers who may not be familiar with these topics are provided. The paper draws upon and updates information from the RBSE Concept Document, baselined by NASA Headquarters, Johnson Space Center, and the University of Houston - Clear Lake in April 1992. Several of NASA's software problems and what RBSE is now doing to address those problems are described. Also, next steps to be taken to derive greater benefit from this Congressionally-mandated program are provided. The section on next steps describes the need to work closely with other NASA software quality, technology transfer, and reuse activities and focuses on goals and objectives relative to this need. RBSE's role within NASA is addressed; however, there is also the potential for systematic transfer of technology outside of NASA in later stages of the RBSE program. This technology transfer is discussed briefly. Author (revised)

N93-28389# Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
STANDARD FAMILIES OF ALGORITHMS [STANDAARD FAMILIES VAN ALGORITMEN]
J. P. M. deVreught 1992 33 p In DUTCH
(Rept-92-20; ETN-93-93114) Copyright Avail: CASI HC A03/MF A01

Abstract and standard families of algorithms are presented. An Abstract Family of Algorithms (AFA) is defined and its properties are outlined. However, several functions cannot be calculated using an AFA. Therefore, a Standard Family of Algorithms (SFA) is defined. An SFA is an AFA with a number of basic properties and represents the basis of several calculation methods. Each SFA contains the recursive functions. If a model is shown to be an SFA, this means that it is at least as powerful as the recursive functions. ESA

N93-28444# Institut National de Recherche d'Informatique et d'Automatique, Valbonne (France). Programme 2: Calcul Symbolique, Programmation et Genie Logiciel.
REAL THEOREM PROVERS DESERVE REAL USER-INTERFACES
Laurent Thery (Cambridge Univ., England.), Yves Bertot, and Gilles Kahn 5 May 1992 24 p Sponsored in part by EEC, and DSTO, Australia
(Grant SERC-GR/G-33837)
(INRIA-RR-1684; ETN-93-93905) Avail: CASI HC A03/MF A01

An explanation of how to add a modern user interface to existing theorem provers, using principles and tools designed for programming environments, is given. The analysis presented is based on experiments pursued with three fairly different, publicy available systems: Felty's prover implemented in lambda-PROLOG, HOL (Higher Order Logic) implemented in ML and LISP, and Isabelle implemented in SML. All three have a programmable top level, so that it is possible to implement the prover's side of the protocol while remaining a conventional system's user. The experimental user interfaces were created using the Centaur system as a toolkit. While the core of the Centaur system is implemented in LISP, it is a meta system and most of the needed code was written in one of Centaur's meta languages. An explanation of how information gets from the user to the theorem prover and back, across the user interface, is given. Technical problems that are more specific to theorem proving environments are discussed: goal directed search and progressive construction of a proof script. With a conventional interface, a user types in a new proof step as a command, in the proof engine's command language. While this must, of course, remain possible, it is shown that the proof environment can provide significant guidance in constructing the next proof step. The major conclusion is that the architecture described is feasible in terms of efficiency. ESA

N93-28446# Institut National de Recherche d'Informatique et d'Automatique, Valbonne (France). Programme 4: Robotique, Image et Vision.
ROBUST AND FAST COMPUTATION OF EDGE CHARACTERISTICS IN IMAGE SEQUENCES
Thierry Vieville and Olivier Faugeras May 1992 48 p
(INRIA-RR-1689; ETN-93-93907) Avail: CASI HC A03/MF A01

A non-parametric analytical model of the intensity for a non-rectilinear edge is considered and the relations between the image data and the edge local characteristics, in the discrete case, are derived. In order to identify this model, the development of high order nonbiased spatial derivative operators, with subpixel accuracy, is also studied. In fact, this discrete approach corresponds to the notion of spatio-temporal surfaces in the continuous case, and provides a way to obtain some of the spatio-temporal parameters from an image sequence. An implementation is proposed, and experimental data are provided. ESA

N93-28455# Sandia National Labs., Albuquerque, NM.
A PROGRAMMING TOOL FOR DETAILED ANALYSIS OF FORTRAN OPERATION COUNTS
G. M. Pollock Feb. 1993 58 p
(Contract DE-AC04-76DP-00789)
(DE93-009606; SAND-92-1370) Avail: CASI HC A04/MF A01

A programming tool was developed to allow detailed analysis of FORTRAN programs for massively parallel architectures. The tool obtains counts for various arithmetic, logical, and input/output operations by data types as desired by the user. The tool operates on complete programs and recognizes user-defined and intrinsic language functions as operations that may be counted. The subset of functions recognized by the tool, STOPCNTR, can be extended by altering the input data sets. This feature facilitates analysis of programs targeted for different architectures. The basic usage and operation of the tool is described along with the more important data structures and more interesting algorithmic aspects before identifying future directions in continued development of the tool and discussing STOPCNTR's inherent advantages and disadvantages. DOE

N93-28460# Sandia National Labs., Albuquerque, NM.
ADAPTIVE PATH PLANNING FOR INCREMENTALLY-CHANGING ENVIRONMENTS
P. C. Chen 1992 16 p Presented at the 10th International Conference on Machine Learning, Amherst, MA, 27-29 Jun. 1993
(Contract DE-AC04-76DP-00789)
(DE93-008411; SAND-92-2744C; CONF-9306111-1) Avail: CASI HC A03/MF A01

Path planning needs to be fast to facilitate real-time robot programming. Unfortunately, current planning techniques are still too slow to be effective, as they often require several minutes, if not hours of computation. To overcome this difficulty, we present an adaptive algorithm that uses previous experience to speed up future performance. It is a learning algorithm suitable for incrementally-changing environments such as those encountered in manufacturing of evolving products and waste-site remediation. The algorithm extends our previous work for stationary environments in two directions: for minor environmental change, an object-attached experience abstraction scheme is introduced to increase the flexibility of the learned experience; and for major environmental change, an on-demand experience repair scheme is also introduced to retain those experiences that remain valid and useful. In addition to presenting this algorithm, we identify three other variants with different repair strategies. To analyze the respective performance of these algorithms, we develop an analytic model that quantifies and relates training effort, experience value and utility, and environmental change through intuitive terms of energy and work. It is a general and simple model that should be very useful in characterizing other types of learning processes as well. Using this model, we formalize the concept of incremental change, and prove the optimality of our proposed algorithm under such change. Empirically, we also characterize the performance curve of each variant, confirm our theoretical optimality results, and demonstrate the practicality of our algorithm. DOE

N93-26949*# Alabama Univ., Huntsville.
DADISP PROCESSING GUIDE
Melissa J. B. Rogers *In its* Acceleration Studies 18 Apr. 1993 23 p
(For primary document see N93-26948 10-12)
Avail: CASI HC A03/MF A01

N93-27211 Rafael Armament Development Authority, Haifa (Israel).
KANE'S DYNAMICS
Shlomo Djerassi *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 373-384 (For primary document see N93-27166 10-01)
Copyright Avail: Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel

N93-27706*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
SPACE STATION FREEDOM SOFTWARE SUPPORT ENVIRONMENT
Susan J. Voigt *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems 1990 p 39-73 (For primary document see N93-27704 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

62 COMPUTER SYSTEMS

Includes computer networks and special application computer systems.

N93-26627# Argonne National Lab., IL.
PARALLEL PROGRAMMING WITH PCN
I. Foster and S. Tuecke Jan. 1993 117 p Revised
(Contract W-31-109-eng-38)
(DE93-008087; ANL-91/32-Rev-2) Avail: CASI HC A06/MF A02

PCN is a system for developing and executing parallel programs. It comprises a high-level programming language, tools for developing and debugging programs in this language, and interfaces to Fortran and C that allow the reuse of existing code in multilingual parallel programs. Programs developed using PCN are portable across many different workstations, networks, and parallel computers. This document provides all the information required to develop parallel programs with the PCN programming system. It includes both tutorial and reference material. It also presents the basic concepts that underlie PCN, particularly where these are likely to be unfamiliar to the reader, and provides pointers to other documentation on the PCN language, programming techniques, and tools. PCN is in the

public domain. The latest version of both the software and this manual can be obtained by anonymous ftp from Argonne National Laboratory in the directory pub/pcn at info.mcs.anl.gov (cf. Appendix A). This version of this document describes PCN version 2.0, a major revision of the PCN programming system. It supersedes earlier versions of this report. DOE

N93-26669# Sandia National Labs., Albuquerque, NM.
MULTIDIMENSIONAL SPECTRAL LOAD BALANCING
B. Hendrickson and R. Leland Jan. 1993 20 p
(Contract DE-AC04-76DP-00789)
(DE93-008362; SAND-93-0074) Avail: CASI HC A03/MF A01

We describe an algorithm for the static load balancing of scientific computations that generalizes and improves upon spectral bisection. Through a novel use of multiple eigenvectors, our new spectral algorithm can divide a computation into 4 or 8 pieces at once. These multidimensional spectral partitioning algorithms generate balanced partitions that have lower communication overhead and are less expensive to compute than those produced by spectral bisection. In addition, they automatically work to minimize message contention on a hypercube or mesh architecture. These spectral partitions are further improved by a multidimensional generalization of the Kernighan-Lin graph partitioning algorithm. Results on several computational grids are given and compared with other popular methods. DOE

N93-27040*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
PARALLEL SOLUTION OF HIGH-ORDER NUMERICAL SCHEMES FOR SOLVING INCOMPRESSIBLE FLOWS
Edward J. Milner, Avi Lin (Pennsylvania Univ., Philadelphia.), May-Fun Liou, and Richard A. Blech Washington Apr. 1993 14 p Original contains color illustrations
(NASA Order C-99066-G; RTOP 505-62-52)
(NASA-TM-4451; E-7345; NAS 1.15:4451) Avail: CASI HC A03/MF A01; 1 functional color page

A new parallel numerical scheme for solving incompressible steady-state flows is presented. The algorithm uses a finite-difference approach to solving the Navier-Stokes equations. The algorithms are scalable and expandable. They may be used with only two processors or with as many processors as are available. The code is general and expandable. Any size grid may be used. Four processors of the NASA LeRC Hypercluster were used to solve for steady-state flow in a driven square cavity. The Hypercluster was configured in a distributed-memory, hypercube-like architecture. By using a 50-by-50 finite-difference solution grid, an efficiency of 74 percent (a speedup of 2.96) was obtained. Author (revised)

N93-27149*# MIMD Systems, Inc., Belmont, CA.
CDM ANALYSIS Technical Report No. 6
Robert E. Larson, Paul L. McEntire, and John G. OReilly 10 Jun. 1993 54 p
(Contract NAS7-1156)
(NASA-CR-193132; NAS 1.26:193132) Avail: CASI HC A04/MF A01

The C Data Manager (CDM) is an advanced tool for creating an object-oriented database and for processing queries related to objects stored in that database. The CDM source code was purchased and will be modified over the course of the Arachnid project. In this report, the modified CDM is referred to as MCDM. Using MCDM, a detailed series of experiments was designed and conducted on a Sun Sparcstation. The primary results and analysis of the CDM experiment are provided in this report. The experiments involved creating the Long-form Faint Source Catalog (LFSC) database and then analyzing it with respect to following: (1) the relationships between the volume of data and the time required to create a database; (2) the storage requirements of the database files; and (3) the properties of query algorithms. The effort focused on defining, implementing, and analyzing seven experimental scenarios: (1) find all sources by right ascension--RA; (2) find all sources by declination--DEC; (3) find all sources in the right ascension interval--RA1, RA2; (4) find all sources in the declination interval--DEC1, DEC2; (5) find all sources in the rectangle defined by--RA1, RA2, DEC1, DEC2; (6) find all sources that meet certain compound conditions; and (7) analyze a variety of query algorithms. Throughout this document, the numerical results obtained from these scenarios are reported; conclusions are presented at the end of the document. Author (revised)

N93-27238*# Illinois Univ. at Urbana-Champaign, Savoy. Coordinated Science Lab.
PERIODIC APPLICATION OF CONCURRENT ERROR DETECTION IN PROCESSOR ARRAY ARCHITECTURES PhD. Thesis -
Paul Peichuan Chen Univ. of Illinois, Urbana, IL 22 Apr. 1993 114 p Sponsored by NASA. Ames Research Center
(Contract N00014-89-K-0070)
(NASA-CR-193217; NAS 1.26:193217; UILU-ENG-93-2214; CRHC-93-08)
Copyright Avail: CASI HC A06/MF A02

Processor arrays can provide an attractive architecture for some applications. Featuring modularity, regular interconnection and high parallelism, such arrays are well-suited for VLSI/WSI implementations, and applications with high computational requirements, such as real-time signal processing. Preserving the integrity of results can be of paramount importance for certain applications. In these cases, fault tolerance should be used to ensure reliable delivery of a system's service. One aspect of fault tolerance is the detection of errors caused by faults. Concurrent error detection (CED) techniques offer the advantage that transient and intermittent faults may be detected with greater probability than with off-line diagnostic tests. Applying time-redundant CED techniques can reduce hardware redundancy costs. However, most time-redundant CED techniques degrade a system's performance. Author

N93-27289*# Stanford Univ., CA. Dept. of Electrical Engineering.
CENTER FOR AERONAUTICS AND SPACE INFORMATION SCIENCES Annual Report, 1992
Michael J. Flynn 1992 62 p
(Grant NAGw-419)
(NASA-CR-193140; NAS 1.26:193140) Avail: CASI HC A04/MF A01

This report summarizes the research done during 1991/92 under the Center for Aeronautics and Space Information Science (CASIS) program. The topics covered are computer architecture, networking, and neural nets. Derived from text

N93-27304# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Numerical Mathematics.
STABILITY OF PARALLEL VOLTERRA-RUNGE-KUTTA METHODS
M. R. Crisci (Naples Univ., Italy.), E. Russo (Naples Univ., Italy.), P. J. vanderHouwen, and A. Vecchio (Consiglio Nazionale delle Ricerche, Naples , Italy.) Apr. 1992 14 p
(CWI-NM-R9207; ETN-93-93261) Copyright Avail: CASI HC A03/MF A01

Parallel Iteration of Volterra-Runge-Kutta (PIVRK) methods for solving second kind Volterra integral equations in parallel computers are presented. The determination of the region of convergence C and on the stability region S(sub m) of the iterated method obtained after m iterations are considered. Results for the convolution test equation are presented. It turns out that the stability region S(sub m) does not necessarily converge to the stability region S of the corrector. However, for finite m, S(sub m) need not be contained in C or S and may be much larger than C. ESA

N93-27361# Technische Univ., Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
COMPLEXITY OF SCHEDULING MULTIPROCESSOR TASKS WITH PRESPECIFIED PROCESSOR ALLOCATIONS
J. A. Hoogeveen, S. L. vandeVelde (Universiteit Twente, Enschede, Netherlands.), and B. Veltman (Center for Mathematics and Computer Science, Amsterdam, Netherlands.) Aug. 1992 19 p
(Memo-COSOR-92-32; ETN-93-93188) Avail: CASI HC A03/MF A01

The computational complexity of scheduling multiprocessor tasks with prespecified processor allocations is investigated. Suppose that a collection of n tasks has to be executed by n processors. Task J(sub j) (j = 1,...,n) requires processing during a given uninterrupted time p(sub j). Each task requires the simultaneous use of a prespecified processor for its execution; each processor can execute at most one task at a time. The following schedule is determined: each task J(sub j) is allocated to a time interval of length p(sub j) such that no two tasks in the same processor overlap. The purpose of the study is two-fold: to find a schedule that minimizes the makespan C(sub max) = max(sub j)C(sub j); and to minimize the sum of the task completion times. ESA

N93-27375# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Numerical Mathematics.
A-STABLE DIAGONALLY IMPLICIT RUNGE-KUTTA-NYSTROM METHODS FOR PARALLEL COMPUTERS
Cong Nguyenhuu (Hanoi Univ., Viet Nam.) Apr. 1992 23 p Sponsored by Amsterdam Univ., Netherlands
(CWI-NM-R9208; ETN-93-93262) Copyright Avail: CASI HC A03/MF A01

Diagonally Implicit Runge-Kutta-Nystrom (DIRKN) methods for use on parallel computers are studied. These methods are obtained by diagonally implicit iteration of fully implicit RKN methods (corrector method). The number of iterations is chosen such that the method has the same order of accuracy as the corrector, and the iteration parameters serve to make the method at least A-stable. Since a large number of the stages can be computed in parallel, the methods are very efficient in parallel computers. A number of A-stable, strongly A-stable, and L-stable DIRKN methods of order p are derived. ESA

N93-27539# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
VERIFICATION OF PARALLEL SYSTEMS VIA DECOMPOSITION
Jan Friso Groote and Faron Moller (Edinburgh Univ., Scotland.) Jan. 1992 24 p Sponsored by Commission of the European Communities and Netherlands Organization for Applied Scientific Research
(CWI-CS-R9203; ETN-93-93216) Copyright Avail: CASI HC A03/MF A01

Decomposition techniques for verification of parallel systems are investigated. The following process is considered: parallel sign(sup n)(sub (i = 1))p(sub i) = parallel sign(sup m)(sub(j = 1)q(sub j), where p(sub i) and q(sub j) are (finite) state systems. A decomposition procedure for all p(sub i) and q(sub j) and criteria that must be checked in the decomposed processes are given. The complexity of the procedure is analyzed and it is shown to be polynomial in n, m, and the sizes of p(sub i) and q(sub j), if there is no communication. It is shown that with communication the verification of the equation of the process considered is co-NP hard, which makes it very unlikely that a polynomial complexity bound exists. But by applying the decomposition technique to Milner's cyclic scheduler it is shown that verification can become polynomial in space and time for practical examples, where standard techniques are exponential. ESA

N93-27548# Naval Postgraduate School, Monterey, CA.
EFFICIENT GRID BASED TECHNIQUES FOR SOLVING THE WEIGHTED REGION LEAST COST PATH PROBLEM ON MULTICOMPUTERS M.S. Thesis
Cengiz Ekin Dec. 1992 100 p
(AD-A262153) Avail: CASI HC A05/MF A02

This thesis explores the possibilities of developing fast grid-based parallel algorithms to solve the Weighted Region Least Cost Path problem. Two complementary steps have been undertaken. First, an efficient sequential algorithm to solve the above problem was developed. The algorithm is a modification of a Gauss-Seidel-like algorithm for obtaining the minimum costs. The most salient feature of the algorithm is the reduction of the number of nodes and edges in cheaper regions of the grid. The reported experimental results ascertain the superiority of this algorithm with regard to computer running time at a modest reduction in the accuracy of the obtained solution. Parallel implementations of grid-based algorithms were studied. A simple grid-based variant was implemented on a network of Transputers. The overall approach employed could be used to develop a parallel version of the above sequential algorithm on a Transputer network, combining both advantages of efficiency and parallelism. DTIC

N93-27623# Ames Lab., IA.
MASSIVELY PARALLEL SEARCHING FOR BETTER ALGORITHMS
J. L. Gustafson and S. Aluru Dec. 1992 38 p
(Contract W-7405-eng-82)
(DE93-009501; IS-5088) Avail: CASI HC A03/MF A01

A number of 'tricks' are known that trade multiplications for additions. The term 'tricks' reflects the way these methods seem not to proceed from any general theory, but instead jump into existence as recipes that work. The Strassen method for 2 x 2 matrix product with seven multiplications is a well-known example, as is the method for finding a complex number product in three multiplications. We have created a practical computer program for finding such tricks automatically, where massive parallelism makes the combinatorially explosive search tolerable for small problems. One result of this program is a method for cross products of 3-vectors that requires only five multiplications. DOE

N93-27657# Carnegie-Mellon Univ., Pittsburgh, PA. Dept. of Computer Science.
THE IMPACT OF COMMUNICATION STYLE ON MACHINE RESOURCE USAGE FOR THE iWarp PARALLEL PROCESSOR
T. Gross, A. Hasegawa, S. Hinrichs, D. OHallaron, and T. Stricker Nov. 1992 25 p
(Contract MDA972-90-C-0035; ARPA Order 7330)
(AD-A262425; CMU-CS-92-215) Avail: CASI HC A03/MF A01

Programs executing on a private-memory parallel system exchange data by explicitly sending and receiving messages. Two communication styles have been identified for such systems: memory communication (each message exchanged between two processors is buffered in memory, e.g. as in message passing) and systolic communication (each word of a message is transmitted directly from the sender processor to receiver processor, without any buffering in memory). The Warp system supports both communication styles and therefore provides a platform that allows us to evaluate how the choice of communication style impacts the usage of processor resources. Parallel program generators map a machine independent description of a computation onto a private-memory parallel system. We use two different parallel program generators that employ the two communication styles to map a set of application kernels onto iWarp. By using tools to generate the parallel programs, we are able to obtain realistic data on the execution of programs using the different communication styles. This paper reports on measurements of instruction format usage, the utilization of the communication ports (gates), and instruction frequencies on the iWarp system. It is a first step towards understanding how features and capabilities of parallel processors are actually used by parallel programs that have been mapped automatically. DTIC

N93-27689# California Univ., San Diego, La Jolla.
RANDOM-LIKE INTERCONNECTS, FAULT TOLERANCE AND GRAIN-SIZE STUDIES FOR OPTOELECTRONIC COMPUTING Final Report, 1 Jul. 1989 - 15 Sep. 1992
S. C. Esener, R. Paturi, and S. H. Lee 15 Sep. 1992 34 p
(Grant AF-AFOSR-0440-89)
(AD-A262360; AFOSR-93-0188TR) Avail: CASI HC A03/MF A01

Our objective during the funding period, 1 Jul. 1989 to 15 Sep. 1992, was to investigate random-like interconnects, fault tolerance, and grain size studies for optoelectronic parallel processors. The major focus has been in the design and analysis of parallel optoelectronic interconnection networks. Two major areas were identified and researched. The first involves the design, analysis, and simulation of perfect shuffle-based optoelectronic multistage interconnection networks (MINs) for highly parallel computers. The objective was first to perform a quantitative performance comparison between optoelectronic and VLSI implementations of MIN's. The next task was to optimize the optoelectronic MIN with respect to architectural and technological parameters. The final goal was to design and simulate a MIN system that could provide a complete set of communication and synchronization services. DTIC

N93-27903# Nijmegen Univ. (Netherlands). Dept. of Informatics.
SOME EXPERIMENTS IN TRANSFORMING TOWARDS PARALLEL EXECUTABILITY
H. A. Partsch 4 Mar. 1992 37 p
(TR-92-08; ETN-93-93142) Avail: CASI HC A03/MF A01

Transformation programming summarizes a methodology for constructing correct and efficient programs from formal specifications by successive applications of (probably) meaning preserving transformation rules. Several experiments on using this methodology, which has proven to be successfully applicable to the systematic development of sequential algorithms, for the formal derivation of algorithms executable on parallel architectures, notably SIMD (Single Instruction Multiple Data) machines, are reported. ESA

N93-27909# Utrecht State Univ. (Netherlands). Dept. of Computer Science.
SPEEDING UP PARALLELISM DETECTION FOR ATTRIBUTE

GRAMMARS
Matthijs F. Kuiper Apr. 1992 14 p
(RUU-CS-92-18; ETN-93-93287) Avail: CASI HC A03/MF A01

Methods for speeding up parallelism detection for attribute grammars are presented. For large existing attribute grammars these methods speed up parallelism detection with factors ranging from 8 to 160. The optimizations exploit the ability to efficiently predict whether a graph introduces useful dependencies and skipping all computations with useless graphs. These predictions are based on an abstract interpretation of dependency graphs. ESA

N93-27951# Yale Univ., New Haven, CT.
EFFICIENT COMMUNICATION FOR PARALLEL COMPUTING Final Report, 1 Jun. 1989 - 31 Dec. 1992
Bhatt Jan. 1993 19 p
(Grant AF-AFOSR-0382-89)
(AD-A261966; AFOSR-93-0088TR) Avail: CASI HC A03/MF A01

The main accomplishments during this grant are in the area of routing algorithms for binary cube networks. DTIC

N93-27990# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.
COMPLEXITY OF SCHEDULING MULTIPROCESSOR TASKS WITH PRESPECIFIED PROCESSOR ALLOCATIONS
J. A. Hoogeveen (Technische Univ., Eindhoven, Netherlands.), S. L. vandeVelde (Universiteit Twente, Enschede, Netherlands.), and B. Veltman Jun. 1992 17 p
(CWI-BS-R9211; ETN-93-93818) Copyright Avail: CASI HC A03/MF A01

The computational complexity of scheduling multiprocessor tasks with prespecified processor allocations is investigated. Two criteria are considered: minimizing schedule length and minimizing the sum of the task completion times. The complexity of problems when precedence constraints or release dates are involved is also investigated. ESA

N93-28061# Utrecht State Univ. (Netherlands). Dept. of Computer Science.
ON PARALLEL DATA STRUCTURING: A PARALLEL PRIORITY QUEUE
S. T. Fischer (Amsterdam Univ., Netherlands.) and M. Veldhorst Apr. 1992 32 p Sponsored in part by Netherlands Organization for Scientifc Research
(Contract EC-3075)
(RUU-CS-92-19; ETN-93-93288) Avail: CASI HC A03/MF A01

The design of a priority queue that is suitable for parallel access on an EREW PRAM is described. To delete p elements with lowest priority from the priority queue takes O((log p) + (log log p) + ((log n)/p)) time. The insertion of p elements in the priority queue takes O(log n + log p) time. To decrease the priority of p elements in the priority queue also takes O(log n + log p) time. ESA

N93-28084# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Numerical Mathematics.
PRECONDITIONING IN IMPLICIT INITIAL VALUE PROBLEM METHODS ON PARALLEL COMPUTERS
P. J. vanderHouwen Sep. 1992 17 p
(CWI-NM-R9216; ETN-93-93814) Copyright Avail: CASI HC A03/MF A01

Parallel step by step methods for solving initial value problems for a variety of functional equations--such as ordinary differential equations, Volterra integral equations, Volterra integro-differential equations, delay differential equations, etc.--are studied. The approach is the parallel iteration of the implicit relations associated with an implicit integration method (the corrector method). The corrector methods are represented in the partitioned general linear method form introduced by Burrage and Butcher. ESA

N93-28222# Stanford Univ., CA. Dept. of Computer Science.
WORKFORM PROCESSING: A NEW PARADIGM FOR FAULT-TOLERANT DISTRIBUTED PARALLEL COMPUTATION Final Report, 1 Aug. 1988 - 31 Jan. 1993
David Cheriton 2 Mar. 1993 17 p
(Contract N00014-88-K-0619)
(AD-A262087) Avail: CASI HC A03/MF A01

This project explored the workform model of parallel processing, looking at its implications for parallel architectures, operating systems, and parallel application structuring. The architecture investigation led to the design and construction of a scalable shared memory multiprocessor, ParaDiGM, that included as novel features: large cache lines, software-controlled caches, locking and messaging support in the caches, and hierarchically shared caches. Various detailed studies coming from this work has shown that these features provide major improvements in cost-effective scalability for parallel computation, particularly parallel simulations. The work on parallel operating system support led to two major innovations, application-controlled page caches, and memory-based messaging. The former allows an application to completely control the allocation of physical memory allocated to it, avoiding unexpected page faults. The latter provides application-level access to the hardware-supported memory-based messaging as well as providing an extended abstraction of this facility. DTIC

N93-28394# Naval Postgraduate School, Monterey, CA. Dept. of Computer Science.
COMPUTER SIMULATION STUDIES OF TWO-DIMENSIONAL BEAMFORMING FOR LINEAR ARRAYS USING A PARALLEL COMPUTER SYSTEM M.S. Thesis
Daniel T. Sullivan Dec. 1992 76 p
(AD-A262712) Avail: CASI HC A05/MF A01

Computer simulation results of a parallel system conducting beamforming for a linear hydrophone array are presented. These studies were performed to determine the best mapping and partitioning of a sequential beamformer program onto a parallel system. Different partition designs and programming methodologies were examined, as well as latencies caused by interprocessor communications. Results of these simulation studies demonstrate that linear scalability in performance is possible by programming with host-node methodology and utilizing efficient interprocessor communications. DTIC

N93-28427*# National Aeronautics and Space Administration. Pasadena Office, CA.
DIGITAL PARALLEL PROCESSOR ARRAY FOR OPTIMUM PATH PLANNING Patent Application
Sabrina E. Kemeny, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.), Eric R. Fossum, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.), and Robert H. Nixon, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) 30 Mar. 1993 32 p
(Contract NAS7-918)
(NASA-Case-NPO-18727-1-CU; NAS 1.71:NPO-18727-1-CU; US-Patent-Appl-SN-042486) Avail: CASI HC A03/MF A01

The invention computes the optimum path across a terrain or topology represented by an array of parallel processor cells interconnected between neighboring cells by links extending along different directions to the neighboring cells. Such an array is preferably implemented as a high-speed integrated circuit. The computation of the optimum path is accomplished by, in each cell, receiving stimulus signals from neighboring cells along corresponding directions, determining and storing the identity of a direction along which the first stimulus signal is received, broadcasting a subsequent stimulus signal to the neighboring cells after a predetermined delay time, whereby stimulus signals propagate throughout the array from starting one of the cells. After propagation of the stimulus signals throughout the array, a master processor traces back from a selected destination cell to the starting cell along an optimum path of the cells in accordance with the identity of the directions stored in each of the cells. NASA

N93-28438# Institut National de Recherche d'Informatique et d'Automatique, Valbonne (France). Programme 2: Calcul Symbolique, Programmation et Genie Logiciel.
A THEORY OF PROCESSES WITH LOCALITIES
Gerard Boudol, Ilaria Castellani, Mathew Hennessy (Sussex Univ., Brighton, England.), and Astrid Kiehn (Technische Univ., Munich, Germany.) Mar. 1992 50 p Sponsored by EEC
(INRIA-RR-1632; ETN-93-93895) Avail: CASI HC A03/MF A01

A notion of observation for concurrent processes which allows the observer to see the distributed nature of processes, giving explicit names for the location of actions, is studied. A general notion of bisimulation

related to this observation of distributed systems is introduced. The main result is that these bisimulation relations, particularized to a process algebra extending CCS (Calculus of Communicating Systems) are completely axiomatizable. Two instances of location bisimulations are discussed, namely the location equivalent and the location preorder. ESA

N93-28453# Pacific Northwest Lab., Richland, WA.
PRODUCTIVITY INCREASES IN SCIENCE
J. E. Danko, ed. Feb. 1993 17 p
(Contract DE-AC06-76RL-01830)
(DE93-009473; PNL-SA-20684) Avail: CASI HC A03/MF A01

The study quantifies the impact on the cost of experimentation of synergistic advancements in instrumentation, theory, and computation over the last two decades. The study finds that the productivity of experimental investigation (experimental results/$) is increasing as science is transformed from a linear, isolated approach to a hierarchical, multidisciplinary approach. Developments such as massively parallel processors coupled with instrumental systems with multiple probes and diverse data analysis capabilities will further this transformation and increase the productivity of scientific studies. The complexities and scale of today's scientific challenges are much greater than in the past, however, so that the costs of research are increasing. Even though science is much more productive in terms of the experimental results, the challenges facing scientific investigators are increasing at an even faster pace. New approaches to infrastructure investments must capitalize on the changing dynamics of research and allow the scientific community to maximize gains in productivity so that complex problems can be attacked cost-effectively. Research strategies that include user facilities and coordinated experimental, computational, and theoretical research are needed. DOE

N93-27715*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
AUTOMATIC MANAGEMENT OF PARALLEL AND DISTRIBUTED SYSTEM RESOURCES
Jerry Yan, Tin Fook Ngai (Stanford Univ., CA.), and Stephen F. Lundstrom (Stanford Univ., CA.) *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems 1990 p 227-247 (For primary document see N93-27704 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

63 CYBERNETICS

Includes feedback and control theory, artificial intelligence, robotics and expert systems.

For related information see also *54 Man/System Technology and Life Support.*

N93-27104# Oak Ridge National Lab., TN.
MOBILE ROBOT NAVIGATION USING QUALITATIVE REASONING
F. G. Pin and Yutaka Watanabe 1993 7 p Presented at the 5th Topical Meeting on Robotics and Remote Systems, Knoxville, TN, 26-29 Apr. 1993
(Contract DE-AC05-84OR-21400)
(DE93-008277; CONF-930403-26) Avail: CASI HC A02/MF A01

Vehicle control in a priori unknown, unpredictable, and dynamic environments requires many calculational and reasoning schemes to operate on the basis of very imprecise. incomplete, or unreliable data. For such systems, in which all the uncertainties can not be engineered away, approximate reasoning may provide an alternative to the complexity and computational requirements of conventional uncertainty analysis and propagation techniques. Two types of computer boards including custom-designed VLSI chips have been developed to add a fuzzy inferencing capability to real-time control systems. The use of these boards and an approach using superposition of elemental sensor-based behaviors for the development of qualitative reasoning schemes emulating human-like navigation are first discussed. We then describe how the human-like navigation schemes were implemented on a test-bed platform to investigate two control modes for driving a car in a priori unknown environments on the basis of sparse and imprecise sensor data. In the first mode, the car navigates fully autonomously, while in the second mode, the system acts as a driver's aid providing the driver with linguistic (fuzzy) commands to turn left or right and speed up or slow down depending on the obstacles perceived by the sensors. Experiments with both nodes of control are described in which the system uses only three acoustic range (sonar) sensor channels to perceive the environment. Simulation results as well as indoors and outdoors experiments are presented and discussed to illustrate the feasibility and robustness of autonomous navigation and/or safety enhancing driver's aid using the new fuzzy inferencing hardware system and methodologies. DOE

N93-27109*# Colorado Univ., Denver. Dept. of Electrical Engineering and Computer Science.
NEURAL SELF-TUNING ADAPTIVE CONTROL OF NON-MINIMUM PHASE SYSTEM
Long T. Ho, Jan T. Bialasiewicz, and Hai T. Ho 1993 12 p Presented at the International Conference on Artificial Neural Networks in Engineering (ANNIE 1993)
(Grant NAG1-1444)
(NASA-CR-193109; NAS 1.26:193109) Avail: CASI HC A03/MF A01

The motivation of this research came about when a neural network direct adaptive control scheme was applied to control the tip position of a flexible robotic arm. Satisfactory control performance was not attainable due to the inherent non-minimum phase characteristics of the flexible robotic arm tip. Most of the existing neural network control algorithms are based on the direct method and exhibit very high sensitivity, if not unstable, closed-loop behavior. Therefore, a neural self-tuning control (NSTC) algorithm is developed and applied to this problem and showed promising results. Simulation results of the NSTC scheme and the conventional self-tuning (STR) control scheme are used to examine performance factors such as control tracking mean square error, estimation mean square error, transient response, and steady state response. Author

N93-27232# Technische Univ., Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
MIXED H2/H INFINITY CONTROL IN A STOCHASTIC FRAMEWORK
M. A. Peters and A. A. Stoorvogel May 1992 23 p Sponsored in part by Royal Netherlands Academy of Sciences and Arts
(MEMO-COSOR-92-13; ETN-93-93169) Avail: CASI HC A03/MF A01

A mixed cost function which combines H2 and the H-infinity norm is investigated. The case of two inputs and one output is considered. One input signal is a white noise stochastic process, and represents errors, for example resulting from measurement noise. The other input has a more deterministic character. If one has a reference signal as input one can not model this as white noise, but it fits nicely into this new class of inputs. The objective is to minimize the effect of these exogenuous signals on the output of the system. A cost function which enables the structural difference between these two exogenuous inputs to be combined is defined. The analysis of this function leads to a standard H-infinity Riccati equation. This cost function is motivated by looking at two theoretical applications: the derivation of robust performance bounds and a tracking problem. ESA

N93-27646# Rome Lab., Griffiss AFB, NY.
NEURAL NETWORKS: RELIABILITY AND DATA ANALYSIS
Paul S. Yaworsky and James M. Vaccaro Jan. 1993 71 p
(AD-A262354; RL-TR-93-5) Avail: CASI HC A04/MF A01

Neural network technology has been surveyed with the intent of determining the feasibility and impact neural networks may have in the area of automated reliability tools. Data analysis capabilities of neural networks appear to be very applicable to reliability science due to similar mathematical foundations. Research on data issues is described with the goal of providing insight into automating intelligent information processing and data analysis. The development of the Statistical Neural Network is also described emphasizing how statistics can be used to indicate and help determine natural tendencies in data. DTIC

N93-27934# Technische Univ., Delft (Netherlands). Faculty of Mechanical Engineering and Marine Technology.
APPROXIMATE IDENTIFICATION AND CONTROL DESIGN WITH APPLICATION TO A MECHANICAL SYSTEM Ph.D. Thesis
Ruud Johannes Petrus Schrama 1992 284 p
(ISBN-90-370-0065-7; ETN-93-93612) Avail: CASI HC A13/MF A03

Iterative schemes of repeated identification and control design are developed. The identification uses data obtained from the system, while it operates under feedback control. The nominal model is used to design a controller, which is applied to the system prior to the next identification stage. At each step in this iteration the stabilizing compensator is known. The knowledge of this compensator is used to represent the system by a dual Youla parameterization. Based on this coprime factor representation, a new identification problem, which solves the problem of approximate identification from closed loop data, is formulated. The coprime factors of the system are identified using frequency response estimates. Thereby concentration can be focused on the asymptotic distribution of the bias due to undermodeling. Each identified nominal model is used to enhance the previously designed controller. For this controller enhancement, a robust control design method, extended with a procedure to determine appropriate weighting functions, is used. A procedure of explicit stability ascertainment is used to guarantee that the new controller will work well with the system, even before it is actually implemented. Having developed the necessary tools, the proposed iterative schemes are tested by a simulation study and by practical experiments. ESA

N93-28051*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

A MODIFIED APPROACH TO CONTROLLER PARTITIONING

Sanjay Garg and Robert J. Veillette (Akron Univ., OH.) May 1993 25 p (RTOP 505-62-50)

(NASA-TM-106167; E-7861; NAS 1.15:106167) Avail: CASI HC A03/MF A01

The idea of computing a decentralized control law for the integrated flight/propulsion control of an aircraft by partitioning a given centralized controller is investigated. An existing controller partitioning methodology is described, and a modified approach is proposed with the objective of simplifying the associated controller approximation problem. Under the existing approach, the decentralized control structure is a variable in the partitioning process; by contrast, the modified approach assumes that the structure is fixed a priori. Hence, the centralized controller design may take the decentralized control structure into account. Specifically, the centralized controller may be designed to include all the same inputs and outputs as the decentralized controller; then, the two controllers may be compared directly, simplifying the partitioning process considerably. Following the modified approach, a centralized controller is designed for an example aircraft mode. The design includes all the inputs and outputs to be used in a specified decentralized control structure. However, it is shown that the resulting centralized controller is not well suited for approximation by a decentralized controller of the given structure. The results indicate that it is not practical in general to cast the controller partitioning problem as a direct controller approximation problem. Author (revised)

N93-28067# Groningen Rijksuniv. (Netherlands). Computing Science Section.

THE REFLECTION OPERATOR IN DISCRETE EVENT SYSTEMS

Rein Smedinga Feb. 1992 29 p

(CS-9201; ETN-93-93326) Avail: CASI HC A03/MF A01

The reflection operator can be defined in discrete event systems to yield a structure outside the normal scope of such systems, but nevertheless very useful in design problems. A study which defines the operator for a Discrete Event System (DES), being a generalization of trace structures, is presented. Controllers are constructed using the reflection operator for which, temporarily, the normal scope of a DES is surpassed. These controllers can be computed effectively, using corresponding (finite) graphs. ESA

N93-28075# Universiteit Twente, Enschede (Netherlands). Dept. of Applied Mathematics.

NONLINEAR H(SUB INFINITY) ALMOST DISTURBANCE DECOUPLING

R. Marino (Tor Vergata Univ., Rome, Italy.), W. Respondek (Polish Academy of Sciences, Warsaw.), A. J. vanderSchaft, and P. Tome (Tor Vergata Univ., Rome, Italy.) Aug. 1992 16 p

(MEMO-1066; ETN-93-93848) Avail: CASI HC A03/MF A01

The H(infinity) almost disturbance decoupling problem for SISO nonlinear systems is formulated. Sufficient conditions are identified for the existence of a parametrized state feedback controller such that the L(sub 2) gain from disturbances to output can be made arbitrarily small by increasing its gain. The controller is explicitly constructed using a Lyapunov based recursive scheme. Some results on internal stability are established. Extensions to the MIMO case and relations with (singular) H(infinity) control are indicated. ESA

N93-28090# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.

A TWO-MACHINE REPAIR MODEL WITH VARIABLE REPAIR RATE

F. A. vanderDuynSchouten (Tilburg Univ., Netherlands.) and P. Wartenhorst Jun. 1992 29 p

(CWI-BS-R9214; ETN-93-93821) Copyright Avail: CASI HC A03/MF A01

A two unit cold standby production system with one repairman is considered. After inspection of a failed unit the repairman chooses either a slow or a fast repair rate to carry out the corresponding amount of work. At system breakdown the repairman has an additional opportunity to switch to the fast rate. If there are no fixed costs associated with system breakdowns, then the policy which minimizes long run average costs is shown to be a two dimensional control limit rule. If fixed costs are incurred every time the system breaks down, then the optimal policy is not necessarily of Control Limit type. This is illustrated by a counterexample. Several performance measures for this maintenance system controlled by a two dimensional control limit rule are presented. ESA

N93-28092# Universiteit Twente, Enschede (Netherlands). Dept. of Electrical Engineering.

ROBUST CONTROL OF ROBOTS USING ONLY POSITION MEASUREMENTS

H. Berghuis and H. Nijmeijer Aug. 1992 22 p Sponsored in part by Netherlands Technology Foundation

(MEMO-1073; ETN-93-93855) Avail: CASI HC A03/MF A01

The control problem of robots using only position measurements is addressed. For this purpose, a model based controller observer combination is presented that originates from the passivity approach to robot control. Characteristic for this approach is that it exploits the physical structure of the robot system, and consequently, yields control methods that possess certain robustness properties. A robustness analysis shows that the proposed controller observer combination is able to face both inaccuracies in the rigid robot model and bounded input disturbances. In particular, in the presence of such uncertainties the closed loop error dynamics is proved to be locally uniformly ultimately bounded. Experimental tests in a two degrees of freedom manipulator system illustrate the robustness properties of the proposed controller observer system and show the improved tracking performance compared to the in practice frequently used numerical position differentiation technique for obtaining a velocity estimate. ESA

N93-28107# Utrecht State Univ. (Netherlands). Dept. of Computer Science.

A RANDOM APPROACH TO MOTION PLANNING

Mark H. Overmars Oct. 1992 26 p Sponsored in part by EEC, and Netherlands Organization for Scientific Research

(RUU-CS-92-32; ETN-93-93864) Avail: CASI HC A03/MF A01

The motion planning problem demands determination of a collision free path for a robot amongst a set of obstacles. An approach for solving this problem, based on the construction of a random network of possible motions, connecting the source and goal configuration of the robot, is presented. Experiments show that the method is very fast compared to other techniques, also when paths are complicated. The method can be seen as a learning strategy in the sense that the network can be reused for further motions (extending it where required) as long as the obstacle environment does not change. The method has only been tested for moving solid robots (allowing translation and rotation) in a planar environment but it can easily be extended to three dimensional workspace and articulated robots. ESA

N93-28155# Universiteit Twente, Enschede (Netherlands). Dept. of Applied Mathematics.

CORRECTION AND SIMPLIFICATION TO THE ORDER OF A STABILIZING REGULATOR IS SUFFICIENT A PRIORI INFORMATION FOR ADAPTIVE STABILIZATION

Bengt Maartensson (Bremen Univ., Germany.) and Jan Willem Polderman Aug. 1992 10 p
(Memo-1070; ETN-93-93852) Avail: CASI HC A02/MF A01

This note corrects a mistake in a referenced document given in the title above. The main conclusion there (as reflected in the title) remains unchanged, only the construction of the 'universal controller' has to be carried out sightly differently. A construction based upon using a dense curve directly, instead of the unnatural approach, using a decomposition in 'size' and 'direction', is presented. ESA

N93-28399# Carnegie-Mellon Univ., Pittsburgh, PA. Dept. of Computer Science.
ESTIMATING SCENE PROPERTIES BY ANALYZING COLOR HISTOGRAMS WITH PHYSICS-BASED MODELS Ph.D. Thesis
Carol L. Novak Dec. 1992 140 p
(Contract F33615-90-C-1465; ARPA Order 7597)
(AD-A262727; CMU-CS-92-222) Avail: CASI HC A07/MF A02

The goal of machine vision is to allow intelligent systems to describe the world around them by the interpretation of images. The difficulty is that vision is a very complex process, since images may contain shadows, highlights, interreflections, and other phenomena. Images are created through the interaction of light with the world; therefore, any vision system that is to understand images must have a model of those interactions. By using physics-based models to describe image formation, we can analyze images in a systematic way. In applying physical models to machine vision, one of the key tools has been color histogram analysis. A color histogram shows the variation of colors observed within the scene. In the mid-1980s, it was recognized that the color variation for a single inhomogeneous surface can be modeled as a regular physical process with a planar distribution in color space. The identification of this plane and the vectors that define it leads directly to an analysis of object color and illumination color. However there is much more to be said about color histograms. The colors do not fall randomly in a plane, but form clusters at specific points in color space. The colors in the histogram relate not only to the color of the object and the illumination, but also to non-color properties of surface roughness and imaging geometry. DTIC

N93-27180 Regional Engineering Coll., Kerala (India). Dept. of Electrical Engineering.
NEW ADAPTIVE CONTROLLERS FOR AIRCRAFT
F. Gajendran *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 116-127 (For primary document see N93-27166 10-01)
Copyright Avail: Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel

N93-27711*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
ELECTRONIC NEURAL NETWORKS
Anil Thakoor *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems 1990 p 141-166 (For primary document see N93-27704 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

N93-27981*# Intec Controls Corp., Walpole, MA.
FLEXIBLE CONTROL TECHNIQUES FOR A LUNAR BASE
Thomas W. Kraus *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 8 p (For primary document see N93-27956 10-91)
Avail: CASI HC A02/MF A03

N93-27982*# Westinghouse Electric Corp., Madison, PA.
THE USE OF AUTOMATION AND ROBOTIC SYSTEMS TO ESTABLISH AND MAINTAIN LUNAR BASE OPERATIONS
Lyman J. Petrosky *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 6 p (For primary document see N93-27956 10-91)
Avail: CASI HC A02/MF A03

N93-27988*# Creativision Consulting, Westwood, CA.
AI IN SPACE: PAST, PRESENT, AND POSSIBLE FUTURES
Donald D. Rose and Jonathan V. Post (Computer Futures, Inc., Altadena, CA.) *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 12 p (For primary document see N93-27956 10-91)
Avail: CASI HC A03/MF A03

64 NUMERICAL ANALYSIS

Includes iteration, difference equations, and numerical approximation.

N93-27061*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
INSTITUTE FOR COMPUTATIONAL MECHANICS IN PROPULSION (ICOMP) Annual Report No. 7, 1992
Charles E. Feiler, comp. May 1993 56 p
(Contract NCC3-233; RTOP 509-90-5K)
(NASA-TM-106155; ICOMP-93-01; E-7839; NAS 1.15:106155) Avail: CASI HC A04/MF A01

The Institute for Computational Mechanics in Propulsion (ICOMP) was established at the NASA Lewis Research Center in Cleveland, Ohio to develop techniques to improve problem-solving capabilities in all aspects of computational mechanics related to propulsion. The activities at ICOMP during 1992 are described. Author

N93-27065*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
GRID ADAPTION USING CHIMERA COMPOSITE OVERLAPPING MESHES
Kai-Hsiung Kao, Meng-Sing Liou, and Chuen-Yen Chow (Colorado Univ., Boulder.) May 1993 34 p Proposed for presentation at the 11th AIAA Computational Fluid Dynamics Conference, Orlando, FL, 6-9 Jul. 1993
(Contract NCC3-233; RTOP 505-90-5X)
(NASA-TM-106163; ICOMP-93-16; E-7855; NAS 1.15:106163; AIAA Paper 93-3389) Avail: CASI HC A03/MF A01

The objective of this paper is to perform grid adaptation using composite over-lapping meshes in regions of large gradient to capture the salient features accurately during computation. The Chimera grid scheme, a multiple overset mesh technique, is used in combination with a Navier-Stokes solver. The numerical solution is first converged to a steady state based on an initial coarse mesh. Solution-adaptive enhancement is then performed by using a secondary fine grid system which oversets on top of the base grid in the high-gradient region, but without requiring the mesh boundaries to join in any special way. Communications through boundary interfaces between those separated grids are carried out using tri-linear interpolation. Applications to the Euler equations for shock reflections and to a shock wave/boundary layer interaction problem are tested. With the present method, the salient features are well resolved. Author (revised)

N93-27068*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ON THE ACCURATE LONG-TIME SOLUTION OF THE WAVE EQUATION IN EXTERIOR DOMAINS: ASYMPTOTIC EXPANSIONS AND CORRECTED BOUNDARY CONDITIONS
Thomas Hagstrom (New Mexico Univ., Albuquerque.), S. I. Hariharan (Akron Univ., OH.), and R. C. MacCamy (Carnegie-Mellon Univ., Pittsburgh, PA.) Apr. 1993 45 p
(Contract NCC3-233; RTOP 505-90-54)
(NASA-TM-106117; ICOMP-93-4; E-7772; NAS 1.15:106117) Avail: CASI HC A03/MF A01

We consider the solution of scattering problems for the wave equation using approximate boundary conditions at artificial boundaries. These conditions are explicitly viewed as approximations to an exact boundary condition satisfied by the solution on the unbounded domain. We study the short and long term behavior of the error. It is provided that, in two space dimensions, no local in time, constant coefficient boundary operator can lead to accurate results uniformly in time for the class of problems we consider. A variable coefficient operator is developed which attains better accuracy (uniformly in time) than is possible with constant coefficient approximations. The theory is illustrated by numerical examples. We also

analyze the proposed boundary conditions using energy methods, leading to asymptotically correct error bounds. Author

N93-27233# Technische Univ., Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
THE CONSTRUCTION OF MINIMAL MULTI-LAYERED PERCEPTRONS: A CASE STUDY FOR SORTING
P. J. Zwietering, E. H. L. Aarts (Philips Gloeilampenfabrieken N.V., Eindhoven, Netherlands.), and J. Wessels (International Inst. for Applied Systems Analysis, Laxenburg, Austria.) Jun. 1992 21 p
(MEMO-COSOR-92-14; ETN-93-93170) Avail: CASI HC A03/MF A01

The construction of minimal multilayered perceptrons for solving combinatorial optimization problems is considered. The construction method is presented as a case study for the sorting problem. The presentation starts with an O((n factorial) squared) three layered perceptron based on complete enumeration, that solves the sorting problem of n numbers. This network is then gradually reduced to an O(n squared) three layered perceptron which can be viewed as a neural implementation of Preparata's parallel enumerative sorting algorithm. ESA

N93-27235# Technische Univ., Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
ON THE NUMBER OF MAXIMA IN A DISCRETE SAMPLE
J. J. A. M. Brands, F. Steutel, and R. J. G. Wilms Jun. 1992 18 p
(MEMO-COSOR-92-16; ETN-93-93172) Avail: CASI HC A03/MF A01

Let M(sub n) = max(N(sub 1), N(sub 2),..., N(sub n)), where N(sub 1), N(sub 2)... are independent and indentically distributed, positive, integer-valued random variables. The number K(sub n) is of interest, which is the number of values of j belonging to the set (1, 2, ..., n) for which N(sub j) = M(sub n). It turns that K(sub n) tends to 1 as n tends to infinity in many cases. The case where N(sub 1) has a geometric distribution is an example of special interest. There is an application of results in K(sub n) to the behavior of the fractional parts of sample maxima from noninteger populations. ESA

N93-27244# Technische Univ., Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
INTRODUCTION TO A BEHAVIORAL APPROACH OF CONTINUOUS-TIME SYSTEMS
S. J. L. vanEijndhoven and J. M. Soethoudt 4 Mar. 1992 42 p
(MEMO-COSOR-92-05; ETN-93-93161) Avail: CASI HC A03/MF A01

The basis for the treatment of the continuous-time systems are presented. The considerations and the context chosen to solve the problem are explained. Some results in Frechet-spaces are given. A few lemmas in differential operators are stated and convolution operators in the C(R) space, a space of continuous functions, are included. A summary of the theory of mean-periodic functions is given. ESA

N93-27245# Technische Univ., Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
INTRODUCTION TO A BEHAVIORAL APPROACH OF CONTINUOUS-TIME SYSTEMS, PART 2
S. J. L. vanEijndhoven and J. M. Soethoudt Jun. 1992 47 p
(MEMO-COSOR-92-17; ETN-93-93173) Avail: CASI HC A03/MF A01

A basis for the treatment of the continuous-time system is presented. A single-input-single-output behavior is assumed. Necessary and sufficient conditions are derived in order to describe this system behavior by a differential equation. In order to avoid imposing smoothness conditions on one external signal, new spaces with the same structure as the Frechet-space C(R) are constructed. With the help of these spaces the generalized differentiability is introduced and the problem of the smoothness conditions is eliminated. ESA

N93-27273# Technische Univ., Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
EXACT CLASSIFICATION WITH TWO-LAYERED PERCEPTRONS
P. J. Zwietering, E. H. L. Aarts (Philips Gloeilampenfabrieken N.V., Eindhoven, Netherlands.), and J. Wessels (International Inst. for Applied Systems Analysis, Laxenburg, Austria.) Jul. 1992 26 p
(MEMO-COSOR-92-25; ETN-93-93181) Avail: CASI HC A03/MF A01

The capabilities of two layered perceptrons for classifying exactly a given subset are studied. Both necessary and sufficient conditions for subsets to be exactly classifiable with two layered perceptrons that use the hard limiting response function are derived. The necessary conditions can be viewed as generalizations of the linear separability condition of one layered perceptrons and confirm the conjecture that the capabilities of two layered perceptrons are more limited than those of three layered perceptrons. The sufficient conditions show that the capabilities of two layered perceptrons extend beyond the exact classification of convex subsets. An algorithmic approach to the problem of verifying the sufficiency condition for a given subset is presented. ESA

N93-27275# Technische Univ., Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
THE MINIMAL NUMBER OF LAYERS OF A PERCEPTRON THAT SORTS
P. J. Zwietering, E. H. L. Aarts (Philips Gloeilampenfabrieken N.V., Eindhoven, Netherlands.), and J. Wessels (International Inst. for Applied Systems Analysis, Laxenburg, Austria.) Apr. 1992 19 p
(Memo-COSOR-92-06; ETN-93-93162) Avail: CASI HC A03/MF A01

The problem of determining the minimal number of layers required by a multilayered perceptron for solving the sorting problem is considered. Two formulations of the sorting problem are discussed: ABSSORT, which can be considered as the standard form of the sorting problem, and where, given an array of numbers, a new array with the original numbers in nondecreasing order is requested; and RELSORT, where, given an array of numbers, one wants to find the smallest number and for each number (except the largest) one wants to find the next largest number. It is shown that, if one uses classical multilayered perceptrons with the hard-limiting response function, the minimal number of layers needed is 3 and 2 for solving ABSSORT and RELSORT, respectively. ESA

N93-27281# Technische Univ., Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
CHARACTERISTIC SETS IN COMMUTATIVE ALGEBRA: AN OVERVIEW
L. C. G. J. M. Habets Jul. 1992 42 p Sponsored by Netherlands Organization for Scientific Research
(MEMO-COSOR-92-24; ETN-93-93180) Avail: CASI HC A03/MF A01

An introduction to the characteristic sets method in constructive commutative algebra is given. The purpose is to determine the relationship between Ritt and Wu characteristic sets. It is shown that a Ritt characteristic set fully determines a prime polynomial ideal. In the irreducible case, the structure of characteristic sets and the link between the definitions of Ritt and Wu is completely determined. This leads in the reducible case to a method for the decomposition of an arbitrary variety into irreducible parts and to an algorithm to solve the membership problem for radical ideals. ESA

N93-27293# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.
ONE-THIRD-INTEGRALITY IN THE METRIC POLYTOPE
Monique Laurent (Paris IX Univ., Dauphine, France.) and Svatopluk Poljak (Karlova Univ., Prague, Czechoslovakia.) May 1992 29 p
(CWI-BS-R9209; ETN-93-93249) Copyright Avail: CASI HC A03/MF A01

The metric polytope MP(sub n) is defined by the triangle inequalities x(sub ij) - x(sub ik) - x(sub jk) less than or equal to zero and x(sub ij) + x(sub ik) + x(sub jk) less than or equal to 2 for i, j, k belonging to the set V = (1,...,n). Several operations preserving 1/d integrality are studied. Several forbidden minors for 1/3 integrality are presented. The 1/3 integral graphs on 7 nodes are characterized. It is proven that series parallel graphs are characterized by a strong property. ESA

N93-27295# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Analysis, Algebra and Geometry.
A SINGULAR PERTURBATION THEOREM FOR EVOLUTION EQUATIONS AND TIME-SCALE ARGUMENTS FOR STRUCTURED POPULATION MODELS
G. Greiner (Tuebingen Univ., Germany.), J. A. P. Heesterbeek (Leiden Univ., Netherlands.), and J. A. J. Metz (Leiden Univ., Netherlands.) Jan. 1992 19 p Sponsored in part by Netherlands Organization for Scientific Research

(CWI-AM-R9201; ETN-93-93251) Copyright Avail: CASI HC A03/MF A01

A generalization of a particular case of Tikhonov's singular perturbation theorem to Banach spaces is presented. From this, sufficient conditions under which a faithful simplification by a time scale argument is justified for age structured population models is obtained. An explicit formulation of the approximating, ordinary differential equation, model is obtained. The precise class of structured population models for which similar results hold is described. It is concluded that from a biological and mathematical point of view the aim is to attempt to extend Tikhonov's result to some of the operators considered. ESA

N93-27296# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Analysis, Algebra and Geometry.

MATHEMATICS AS TECHNOLOGY: MATHEMATICAL ENGINEERING

Gerard Alberts Jan. 1992 13 p

(CWI-AM-R9202; ETN-93-93252) Copyright Avail: CASI HC A03/MF A01

An historical review of the mathematical engineering discipline, since it was introduced for the first time at the Delft Technische Hogeschool, by Reiner Timman, is given. Surmounting traditional applied mathematics by the new style of mathematical modeling, he placed mathematical thought in a surprising technological perspective. After 150 years of diametrical opposition to practice within the engineering disciplines, mathematics was presented as another engineering discipline itself. The pure science of mathematics was reintegrated in the broader stream of mathematical thought. The appeal to mathematical thought was now caught in a procedure, mathematical modeling. Being a procedure, modeling made mathematical thinking as such appear under a technological aspect. ESA

N93-27300# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Numerical Mathematics.

A FINITE VOLUME DISCRETISATION SCHEME WITH A-POSTERIORI ERROR ESTIMATES FOR THE SYMMETRISED CONTINUITY EQUATION

R. R. P. vanNooyen Mar. 1992 26 p Submitted for publication

(CWI-NM-R9203; RTN-93-93257) Copyright Avail: CASI HC A03/MF A01

The purpose of the investigation is the derivation of an a posteriori error estimate for the Scharfetter-Gummel discretization of the continuity equations in the semiconductor problem. The deferred correction method to derive an a posteriori error estimate is used. The stability and consistency of the discretization scheme is proven. The analysis shows that the discretization error for the Scharfetter-Gummel scheme is second order in areas of constant cell size and slowly varying electrical potential. It also shows the scheme to be only first order accurate if the ratio of adjacent cell edges differs too much from one or if the number of boundary cells is a large fraction of the total number of cells. A model problem, the discretization spaces to be used, and a description of the discretization are given. Conditions that imply existence of the solution and stability of the problem are presented. A quadrature rule, the consistency, and the a posteriori error estimate are investigated. Results and some conclusions are presented. ESA

N93-27301# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Numerical Mathematics.

A PETROV-GALERKIN MIXED FINITE ELEMENT METHOD WITH EXPONENTIAL FITTING

R. R. P. vanNooyen Mar. 1992 24 p Submitted for publication

(CWI-NM-R9204; ETN-93-93258) Copyright Avail: CASI HC A03/MF A01

A Petrov-Galerkin fixed finite element formulation of the semiconductor continuity equations on a rectangular domain is discussed. Error estimates for equations that are in principle degenerate on the singularity perturbed case are given. Arguments that indicate that the method is also effective in the singularity perturbed case are considered. A discretization that gives a higher order accurate solution for use in an a posteriori error estimator is developed. ESA

N93-27302# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Numerical Mathematics.

A COMPARISON BETWEEN DIRECT AND ITERATIVE METHODS TO SOLVE THE LINEAR SYSTEMS ARISING FROM A TIME-DEPENDENT 2D GROUNDWATER FLOW MODEL

J. G. Blom, J. G. Verwer, and R. A. Trompert Apr. 1992 18 p Submitted for publication Sponsored by Netherlands Organization for Scientific Research, and Ministry of Economic Affairs, The Hague, Netherlands

(CWI-NM-R9205; ETN-93-93259) Copyright Avail: CASI HC A03/MF A01

Various methods for solving nonsymmetric linear systems are compared. Both direct and ILU preconditioned iterative solvers are considered. The linear systems arise when the implicit BDF time stepping method in combination with modified Newton is applied to a system of nonlinear time dependent two dimensional Partial Differential Equation (PDE). The PDE system under study is a groundwater flow model simulating transport of brine. The brine transport model used and an outline of the method to solve the system of PDEs are given. The relevant differences between the straightforward way used to solve the system of PDEs and the above mentioned adaptive grid method are discussed. The linear solvers are presented. Some implementation details on the stopping criteria used are given. The actual comparison of the linear solvers follows, both with respect to their memory efficiency and with respect to the computational complexity. This comparison involves running tests in vector mode on 1 CPU of a Cray Y-MP and in scalar mode on an IBM ES/9000. ESA

N93-27303# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Numerical Mathematics.

MOVING-FINITE-ELEMENT SOLUTION OF TIME-DEPENDENT PARTIAL DIFFERENTIAL EQUATIONS IN TWO SPACE DIMENSIONS

P. A. Zegeling Apr. 1992 23 p Submitted for publication

(CWI-NM-R9206; ETN-93-93260) Copyright Avail: CASI HC A03/MF A01

The aim is to show the capability of the two dimensional moving finite element method (MFE) to solve different kinds of time dependent partial differential equations having solutions with steep moving fronts, rotating pulses, or other features involving time scale structures. Some difficulties that can arise are discussed: the treatment of second order differential operators in combination with MFE. The numerical performance of MFE applied to three model examples, each from a different subclass of partial differential equations, is studied. Some of the examined aspects are: the efficiency of the temporal integration process, the effect of the regularization parameters (penalties), and the effect of the partial differential equations diffusion coefficient. A more sophisticated application of MFE to a two dimensional brine transport problem in a porous medium is discussed. ESA

N93-27305# Utrecht State Univ. (Netherlands). Dept. of Computer Science.

ON THE TREEWIDTH AND PATHWIDTH OF PERMUTATION GRAPHS

T. Kloks and H. Bodlaender Mar. 1992 11 p Sponsored in part by Netherlands Foundation for Computer Science

(RUU-CS-92-13; ETN-93-93282) Avail: CASI HC A03/MF A01

The problem of finding the treewidth and patchwidth of permutation graphs is discussed. If G(pi) is a permutation graph with treewidth k, it is shown that its pathwidth is at most 2k. An algorithm which constructs a path decomposition with width at most 2k in time O(nk) is given. It is assumed that the permutation pi is given. For permutation graphs of which the treewidth is bounded by some constant, this result shows that the treewidth and pathwidth can be computed in linear time. ESA

N93-27310# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Analysis, Algebra and Geometry.

ASYMPTOTIC ESTIMATES OF STIRLING NUMBERS

N. M. Temme Apr. 1992 12 p

(CWI-AM-R9204; ETN-93-93254) Copyright Avail: CASI HC A03/MF A01

The purpose of the study is to present new expansion for the Stirling numbers which hold uniformly with respect to m. New asymptotic estimates are given of the Stirling numbers of first and second kind as n tends to

infinity. The method is based on a modification of the saddle point method. Short tables are given to show the results for n = 10. Computer experiments confirm the uniform character of the estimates. ESA

N93-27362# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
REAL TIME PROCESS ALGEBRA WITH PREFIXED INTEGRATION
Willem Jan Fokkink and A. Steven Klusener Jun. 1992 47 p Sponsored in part by EEC
(CWI-CS-R9219; ETN-93-93232) Copyright Avail: CASI HC A03/MF A01

An abstract operational semantics without the idle transition is given. Due to a simplification and by restricting to prefixed integration, soundness and completeness can be proven. It is shown that equality between process terms is decidable. The Basic real time Process Algebra (BPA(rho)(delta)) consisting of timed actions, sequential composition, and alternative composition is discussed. The BPA(rho)(delta) operational semantics is presented. The theory of BPA(rho)(delta) together with a new operational semantics that abstracts from idle transitions are outlined. The completeness of BPA(rho)(delta) is proven. Communication operators are added, and the resulting Asynchronous Communication Process(rho) (ACP(rho)) theory is presented. The BPA(rho)(delta)(1) is developed, and by adding communication operators, the ACP(rho)(delta)(1) theory is developed. ESA

N93-27364# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Numerical Mathematics.
ANALYSIS OF LOCAL UNIFORM GRID REFINEMENT
J. G. Verwer and R. A. Trompert Jun. 1992 21 p Presented at the 7th IMACS International Conference on Computer Methods for Partial Differential Equations, New Brunswick, NJ, 22-24 Jun. 1992 Submitted for publication
(CWI-NM-R9211; ETN-93-93264) Copyright Avail: CASI HC A03/MF A01

Numerical methods for time dependent partial differential equations usually integrate on a fixed grid chosen in an a priori manner for the whole time interval. Similar to a fixed stepwise, a fixed grid may be inefficient when solutions possess large local gradients. While most schemes can easily adapt the stepwise, as on genuine ordinary differential equation and method of lines schemes, the question of how to automatically adapt the grid to rapid spatial transitions is much more involved. The Local Uniform Grid Refinement (LUGR) for finite difference methods is discussed. The idea of LUGR is to cover the spatial domain with finely nested, locally uniform subgrids. LUGR is applicable both to stationary and time dependent problems. For time dependent problems, the local subgrids are adapted at discrete values of time to follow eventually moving transitions. The aim is to discuss, for the class of finite difference methods under consideration, a general error analysis that shows the interplay between local truncation and interpolation errors. This analysis points the way to a theoretically optimal strategy for the local refinement, optimal in the sense that this strategy controls accumulation of interpolation errors and simultaneously strives for the spatial accuracy that could be obtained on the finest grid when used without adaptation. Attention is paid to both the stationary and time dependent case, while for time dependent problems, the emphasis lies on combining LUGR with Runge-Kutta time stepping. ESA

N93-27365# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Numerical Mathematics.
ERROR ANALYSIS AND LOCAL REFINEMENT FOR A ONE-DIMENSIONAL, SCALAR CONSERVATION LAW
H. T. M. vanderMaarel Jun. 1992 28 p
(Contract AERO-0003/1094)
(CWI-NM-R9210; ETN-93-93265) Copyright Avail: CASI HC A03/MF A01

For the upwind discretization of a one dimensional, scale conservation law, the local truncation error and its a posteriori estimation on a locally refined grid are studied. The estimate can be used in a refinement criterion of a solution adaptive refinement procedure. Local refinement in a nonlinear multigrid context and estimating in the neighborhood of the interface between a coarse and fine grid are discussed. In the neighborhood of such a grid interface the discretization scheme used is different from the one used elsewhere. Estimating the local truncation error in such a situation using extrapolation techniques, requires different treatment of the various contributions to the local truncation error. Two discretizations at grid interfaces and a procedure for the estimation of the local truncation error are introduced. It is shown for a model problem that under sufficient smoothness conditions, the estimate is sufficiently accurate. ESA

N93-27366# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Numerical Mathematics.
FACTORIZATIONS OF a(SUB n) +/- 1, 13 LESS THAN OR EQUAL TO a LESS THAN 100
Richard P. Brent (Australian National Univ., Canberra.) and Herman J. J. teRiele Jun. 1992 190 p
(CWI-NM-R9212; ETN-93-93266) Copyright Avail: CASI HC A03/MF A02

Tables of factorization of a to the nth power +/- 1 for a greater than or equal to 13 and less than or equal to 100 are presented as an extension of the Cunningham tables. The components n satisfy a to the nth power is less than 10 to the 255th power of a is less than 30, and n is less than or equal to 100 if a is greater than or equal to 30. The factorizations are completed for n less than or equal to 46, and the tables contain no composite numbers smaller than 10 to the 80th power. ESA

N93-27370# Utrecht State Univ. (Netherlands). Dept. of Computer Science.
A TOURIST GUIDE THROUGH TREEWIDTH
Hans L. Bodlaender Mar. 1992 20 p
(RUU-CS-92-12; ETN-93-93281) Avail: CASI HC A03/MF A01

A short overview of many recent results in algorithmic graph theory that deal with the notions of tree widths and patchwidth is given. Algorithms that find tree decompositions, algorithms that use tree decompositions to solve hard problems efficiently, graph minor theory, and some applications are discussed. The main definitions, the basic idea behind linear time algorithms on graphs with constant bounded treewidth are given. Some results that deal with graph minors and algorithms that find 'suitable' tree- or paths-decompositions are presented. It should be noted that the constant factors, hidden in the 'O' notation can be quite large for several of the algorithms. In many cases, additional ideas will be required to turn the described methods into practical algorithms. ESA

N93-27376# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Numerical Mathematics.
ERROR ANALYSIS FOR THE ONE-DIMENSIONAL CONVECTION-DIFFUSION EQUATION
R. R. P. vanNooyen Jun. 1992 17 p Submitted for publication
(CWI-NM-R9209; ETN-93-93263) Copyright Avail: CASI HC A03/MF A01

Uniform error estimates for a class of Petrov-Galerkin mixed finite element methods for the one dimensional convection diffusion equation are derived. Such estimates are obtained for the flux of the solution, but not for the solution itself. However, uniform error estimates are obtained for the difference between discrete approximation and a problem dependent projection of the solution. An estimate for the average of the absolute value of that difference in a cell is given. As the projection is close to the normal L squared (omega) projection for all mesh cells where convection and diffusion are of the same order of magnitude, this shows that local singular perturbation does not have a global effect. Several theorems on the regularity of the continuous problem are proven. ESA

N93-27381# Utrecht State Univ. (Netherlands). Dept. of Computer Science.
TERMINATION OF TERM WRITING BY INTERPRETATION
H. Zantema Apr. 1992 23 p
(RUU-CS-92-14; ETN-93-93283) Avail: CASI HC A03/MF A01

How to prove termination of term rewriting systems by interpretation of terms is investigated. This can be considered as a generalization of polynomial interpretations. A classification of types of termination built in properties on the semantic level is proposed. A transformation on term rewriting systems eliminating distributive rules is introduced. A construction of eliminating a particular operation symbol from a term rewriting system is given. Under some restrictions it is proven that termination of the original system can be derived from termination of the eliminated system. It is called distribution elimination since distributive rules are removed completely.

For a classical example of a term rewriting system of which termination is very hard to prove a simple termination proof using distribution elimination is given. ESA

N93-27397# Technische Univ., Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
THE COMPENSATION APPROACH APPLIED TO A 2 BY 2 SWITCH
O. J. Boxma (Center for Mathematics and Computer Science, Amsterdam, Netherlands.) and G. J. vanHoutum Jul. 1992 28 p
(Memo-COSOR-92-28; ETN-93-93184) Avail: CASI HC A03/MF A01

An asymmetric 2 by 2 buffered switch, fed by two independent Bernoulli input streams is analyzed. The joint equilibrium distribution of the numbers of messages waiting in the two output buffers is derived. This joint distribution is presented, without the use of generating functions, in the form of a sum of two alternating series of product form geometric distributions. The method used is the so called compensation approach. ESA

N93-27469# Universiteit Twente, Enschede (Netherlands). Faculty of Applied Mathematics.
CONTRIBUTIONS TO THE TWENTE WORKSHOP ON HAMILTONIAN GRAPH THEORY
H. J. Broersma, ed., J. vandenHeuvel, ed., and H. J. Veldman, ed. Mar. 1992 89 p Workshop held in Twente, Netherlands, 6-10 Apr. 1992
(Memo-1043; ETN-93-93592) Avail: CASI HC A05/MF A01

The following contributions were presented: the Hamiltonian-connectedness of Cayley graphs; the Hamiltonian properties of two-tough graphs; toughness and the cycle structure of graphs; the Hopping Lemma; cycles containing all vertices of maximum degree; long paths and cycles in tough graphs; the complete closure and the generalized closure of a graph; two problems related to results of Chvatal-Erdoes; the circumference of certain families of graphs; ore type conditions for cycles through specified vertices; Hamilton cycles in path-tough graphs; and cubic graphs containing k vertex-disjoint subgraphs of given cyclomatic number. For individual titles, see N93-27470 through N93-27482.

N93-27470# Simon Fraser Univ., Burnaby (British Columbia). Dept. of Mathematics and Statistics.
ON HAMILTON-CONNECTEDNESS OF CAYLEY GRAPHS
Brian Alspach *In* Univ. Twente, Contributions to the Twente Workshop on Hamiltonian Graph Theory Mar. 1992 p 7-8 (For primary document see N93-27469 10-64)
Avail: CASI HC A01/MF A01

The question of whether or not every connected Cayley graph has a Hamilton cycle is discussed. A result about Cayley graphs in abelian groups is stated. If a graph X has the property that given any two vertices u and v there is a Hamilton path whose end vertices are u and v, we say X is Hamilton connected. If a bipartite graph X, whose bipartition sets A and B have the same cardinality, has the property that for any vertex u belongs to A and v belongs to B there is a Hamilton path whose end vertices are u and v, we say X is Hamilton-laceable. The following theorem is discussed: let X be a connected Cayley graph of degree at least 3 in an abelian group. If X is bipartite, then X is Hamilton laceable. If X is not bipartite, then X is Hamilton connected. ESA

N93-27471# Universiteit Twente, Enschede (Netherlands).
ON HAMILTONIAN PROPERTIES OF 2-TOUGH GRAPHS
D. Bauer, H. J. Broersma, J. vandenHeuvel, and H. J. Veldman *In its* Contributions to the Twente Workshop on Hamiltonian Graph Theory Mar. 1992 p 9-13 (For primary document see N93-27469 10-64)
Avail: CASI HC A01/MF A01

A graph, G, is called Hamiltonian if it contains a Hamiltonian cycle (a cycle containing every vertex of G). The graph is called t-tough if the absolute value of S is greater than or equal to (t w(G-S)) for every subset S subset of V(G), with W(G-S) greater than 1. The toughness of G is the maximum value of t for which G is t-tough. The relations between toughness and the existence of Hamiltonian factors or k factors are studied. The following conjectures and theorems are stated: a two-tough graph on at least 3 vertices is Hamiltonian; the square of a two-connected graph is Hamiltonian; a four connected line graph is Hamiltonian; a 7 connected line graph is Hamiltonian; and a four-connected K(sub 1,3) free graph is Hamiltonian. ESA

N93-27472# Stevens Inst. of Tech., Hoboken, NJ. Dept. of Mathematics.
TOUGHNESS AND THE CYCLE STRUCTURE OF GRAPHS
D. Bauer and E. Schmeichel (San Jose State Univ., CA.) *In* Univ. Twente, Contributions to the Twente Workshop on Hamiltonian Graph Theory Mar. 1992 p 15-19 (For primary document see N93-27469 10-64)
(Contract MDA904-89-H-2008; NSF DMS-89-04520)
Avail: CASI HC A01/MF A01

The relationship between the toughness of a graph and its cycle structure is discussed. The study was motivated by the conjecture that there exists a constant t(sub zero) such that every t(sub zero)-tough graph is Hamiltonian. The following definitions are explained. The graph G is called t-tough if the absolute value of S is greater than or equal to (tw(G-S)) for every subset S subset if V(G), with W(G-S) greater than 1; the circumference of G is denoted by the length of a longest cycle in G. Directions for future research are given. ESA

N93-27473# Waterloo Univ. (Ontario).
THE HOPPING LEMMA M.S. Thesis
Kerstin Baxter *In* Univ. Twente, Contributions to the Twente Workshop on Hamiltonian Graph Theory Mar. 1992 p 21-48 (For primary document see N93-27469 10-64)
Avail: CASI HC A03/MF A01

The Hopping Lemma is one of the different proof techniques used in graph theory. Used specifically for path and circuit problems, it is based on an iterative definition of sets of vertices in a graph with respect to a chosen circuit or path. Many variants and results based on it were performed. The Lemma and its variants, attempting to show the links between these concepts, are stated and proven. A survey of results proved using the Hopping Lemma or one of its variants is included. ESA

N93-27474# Universiteit Twente, Enschede (Netherlands).
CYCLES CONTAINING ALL VERTICES OF MAXIMUM DEGREE
H. J. Broersma, J. vandenHeuvel, H. A. Jung, and H. J. Veldman *In* Univ. Twente, Contributions to the Twente Workshop on Hamiltonian Graph Theory Mar. 1992 p 49-53 (For primary document see N93-27469 10-64)
Avail: CASI HC A01/MF A01

The maximum degree of a graph is discussed. Let G be a graph and let C be a cycle of G and A and B subsets of V(G). The following definitions are given for a cycle C: A-longest, A-dominating, (A,B)-extendable, A-extendable. A variation of Woodall's Hopping Lemma is presented. It is shown that a Lemma and some of the corollaries presented remain valid if (braces)a(braces) is replaced by a subset S of V(G) - V(C) such that every pair of vertices in the intersection of N(S) and V(C) is joined by a path with all internal vertices in S and at least one interval vertex in A. The results and the open problems are discussed. An extension of Jackson's theorem is presented. ESA

N93-27475# Universiteit Twente, Enschede (Netherlands).
LONG PATHS AND CYCLES IN TOUGH GRAPHS
H. J. Broersma, J. vandenHeuvel, H. J. Veldman, and H. A. Jung *In its* Contributions to the Twente Workshop on Hamiltonian Graph Theory Mar. 1992 p 55-60 (For primary document see N93-27469 10-64)
Avail: CASI HC A02/MF A01

The length of longest cycles in t-tough graphs is discussed. The investigation was motivated by the following observation: given a k connected (k greater than or equal to 2) graph on n greater than or equal to k vertices, then a longest cycle in that graph has length at least k. The results concerning the length of longest cycles and paths in t-tough graphs are given. Bounds with the right order of magnitude for t greater than zero and inferior or equal to 1 are achieved. However, for the length of longest cycles, the right order of magnitude is not known. ESA

N93-27476# Memphis State Univ., TN. Dept. of Mathematical Sciences.
THE COMPLETE CLOSURE OF A GRAPH
Ralph Faudree, Odile Favaron (Paris-Sud Univ., Orsay, France.), Evelyne Flandrin (Paris-Sud Univ., Orsay, France.), and Hao Li (Paris-Sud Univ., Orsay, France.) *In* Univ. Twente, Contributions to the Twente Workshop on Hamiltonian Graph Theory Mar. 1992 p 61-66 Sponsored in part

by PRC MathInfo (For primary document see N93-27469 10-64)
Avail: CASI HC A02/MF A01

The complete closure number cc(G) of a graph G of order n is defined as the greater integer k less than or equal to 2n - 3 such that the kth Bondy-Chvatal closure Cl sub k (G) is complete. The necessary or sufficient conditions for a graph to have cc(G) = k are given. The complete stability cs(p) of a property P defined in all the graphs of order n is the smallest integer k such that if Cl sub k (G) is complete then G satisfies P. For some properties P, cs(P) is compared with the classical stability s(P) of P and it is shown that cs(P) may be far smaller than s(P). ESA

N93-27477# Erivan State Univ. (USSR). Dept. of Mathematical Cybernetics.
GENERALIZED CLOSURES OF GRAPHS
A. S. Hasratian and N. K. Khachatrian (Academy of Sciences of the Armenian SSR, Erivan.) *In* Univ. Twente, Contributions to the Twente Workshop on Hamiltonian Graph Theory Mar. 1992 p 67-72 (For primary document see N93-27469 10-64)
Avail: CASI HC A02/MF A01

The method proposed by Bondy and Chvatal to investigate graphs using closures is summarized. Properties involving a C(to the 2nd power) of a graph are presented. The following definition is given: let the graph H be a supergraph of a graph of G. H is the generalized C(to the 2nd power) closure of G, under given conditions. The following theorem is proved: the graph K(sub n) is the generalized closure of any Fan's graph G on n greater than or equal to 3 vertices. ESA

N93-27478# Erivan State Univ. (USSR). Dept. of Mathematical Cybernetics.
TWO PROBLEMS RELATED TO RESULTS OF CHVATAL-ERDOS
A. S. Hasratian and N. K. Khachatrian (Academy of Sciences of the Armenian SSR, Erivan.) *In* Univ. Twente, Contributions to the Twente Workshop on Hamiltonian Graph Theory Mar. 1992 p 73-74 (For primary document see N93-27469 10-64)
Avail: CASI HC A01/MF A01

The following problems are discussed: to find a localization of the conditions alpha (G) less than or equal to k(G) + 1 sufficient for traceability of a graph G; is a connected graph G = (V, E) Hamiltonian if the absolute value of V is greater than or equal to 3 and for each vertex v belonging to V there exists a positive integer n(v) such that alpha (G(sub n(v))(v)) less than or equal to k (G(sub n(v))(v)). ESA

N93-27479# London Univ. (England). Dept. of Mathematical Studies.
CONCERNING THE CIRCUMFERENCE OF CERTAIN FAMILIES OF GRAPHS
Bill Jackson *In* Univ. Twente, Contributions to the Twente Workshop on Hamiltonian Graph Theory Mar. 1992 p 75-82 (For primary document see N93-27469 10-64)
Avail: CASI HC A02/MF A01

Bounds on the circumference of planar graphs, graphs of bounded maximum degree, claw free graphs, and t-tough graphs are discussed. The results and problems concerning the order of magnitude of F(sub k(n)) when F is one of the families of planar graphs of bounded maximum degree, claw free, and t-tough graphs are studied. Proof techniques used in the three connected cases are indicated. ESA

N93-27480# Nihon Univ., Tokyo (Japan). Dept. of Mathematics.
ORE-TYPE CONDITIONS FOR CYCLES THROUGH SPECIFIED VERTICES
Akira Saito *In* Univ. Twente, Contributions to the Twente Workshop on Hamiltonian Graph Theory Mar. 1992 p 83 (For primary document see N93-27469 10-64)
Avail: CASI HC A01/MF A01

The generalization of a Hamiltonian cycle is discussed. Ore's theorem states that a graph G of order p is Hamiltonian if deg(sub G)(x) + deg(sub G)(y) is greater than or equal to p for all nonadjacent pairs of vertices x, y of G. If a Hamiltonian cycle is interpreted as a cycle through all vertices of the graph, a similar degree sum condition which assures the existence of a Hamiltonian cycle can be considered. ESA

N93-27481# Technische Hochschule, Aachen (Germany). Lehrstuhl fuer Mathematik.
HAMILTON CYCLES IN PATH-TOUGH GRAPHS
Ingo Schiermeyer *In* Univ. Twente, Contributions to the Twente Workshop on Hamiltonian Graph Theory Mar. 1992 p 85-87 (For primary document see N93-27469 10-64)
Avail: CASI HC A01/MF A01

Undirected and simple graphs on n greater than or equal to 3 vertices are considered. A graph G is called 1-tough if any proper subset S which is a proper subset of V(G), with w(G-S) greater than or equal to 2, w(G-S) is less than or equal to the absolute value of S. The theorems of Dirac and Ore, which state the sufficient conditions for a graph to have a Hamilton cycle, and the Jung theorem are given. The path toughness of a graph G is defined. Theorems to demonstrate whether a cycle is Hamiltonian or non-Hamiltonian are shown. ESA

N93-27482# Paedagogische Hochschule, Dresden (Germany).
CUBIC GRAPHS CONTAINING k VERTEX-DISJOINT SUBGRAPHS OF GIVEN CYCLOMATIC NUMBER
Heinz-Juergen Voss *In* Univ. Twente, Contributions to the Twente Workshop on Hamiltonian Graph Theory Mar. 1992 p 89-93 (For primary document see N93-27469 10-64)
Avail: CASI HC A01/MF A01

Finite undirected graphs G = (V, E) with vertex set V and edge set E are considered. Loops and multiple edges are allowed. The cardinalities (V) and (E) are called the order and the size of G. The cyclomatic number z(G) of a graph G is the smallest number of edges such that the deletion of these edges results in a cycle-free graph. A parameter s(G) of graphs G = (V, E), where s(G) = def(E) - (V) is considered. This parameter is related with the cyclomatic number. If G is connected then s(G) = z(G) - 1, and if G has alpha components then s(G) = z(G) - alpha. ESA

N93-27498# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
BISIMULATION SEMANTICS FOR CONCURRENCY WITH ATOMICITY AND ACTION REFINEMENT
J. W. deBakker (Vrije Univ., Amsterdam, Netherlands.) and E. P. deVink (Vrije Univ., Amsterdam, Netherlands.) Mar. 1992 34 p Sponsored by Netherlands Organization for Applied Scientific Research
(CWI-CS-R9210; ETN-93-93223) Copyright Avail: CASI HC A03/MF A01

A comparative semantic study is made of two notions in concurrency: atomicity and action refinement. Parallel composition is modeled by interleaving, and refinement is taken in the version where actions are refined by atomized statements. The bisimulation domain used in the semantic definitions is obtained as solution of a system of domain equations over complete metric spaces. Both operational and denotational models are developed. Their equivalence is established using higher order techniques and Banach's fixed point theorem. The operational semantics for refinement is based on transition rules rather than on some form of syntactic substitution. ESA

N93-27505# Utrecht State Univ. (Netherlands). Dept. of Computer Science.
IMPLICIT POINT LOCATION IN ARRANGEMENTS OF LINE SEGMENTS, WITH AN APPLICATION TO MOTION PLANNING
Pankaj K. Agarwal (Duke Univ., Durham, NC.) and Marc vanKreveld Apr. 1992 20 p Sponsored in part by EEC Project ALCOM
(Grant NSF CCR-91-06514)
(RUU-CS-92-15; ETN-93-93284) Avail: CASI HC A03/MF A01

Let S be a set of n (possibly intersecting) line segments in the plane. It is shown that the arrangements of S can be stored implicitly into a data structure of size O(n(log squared of n)) so that the following query can be answered in time O((square root of n)(log squared of n)): given two query points, determine whether they lie in the same face of the arrangement of S and, if so, return a path between them that lies within the face. This version of the implicit point location problem is motivated by the following motion planning problem: given a polygonal robot R with m vertices and a planar region bounded by polygonal obstacles with n vertices in total, preprocess them into a data structure so that, given initial and final positions of R, one can quickly determine whether there exists a continuous

collision-free translational motion of R from the initial to the final position. It is shown that such a query can be answered in time O((square root of mn)(log squared mn)) using O(mn(log squared of mn)) storage. ESA

N93-27526# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.

GRID MINORS OF GRAPHS ON THE TORUS

Maurits deGraaf (Amsterdam Univ., Netherlands.) and Alexander Schrijver (Amsterdam Univ., Netherlands.) Apr. 1992 8 p

(CWI-BS-R9205; ETN-93-93245) Copyright Avail: CASI HC A02/MF A01

It is shown that any graph G embedded on the torus with face-width r greater than or equal to 5 contains the toroidal (2/3 r) grid as a minor. For each fixed r greater than or equal to 5, the value (2/3 r) is largest possible. This applies to a theorem of Robertson and Seymour showing, for each graph H embedded on any compact surface S, the existence of a number rho(sub H), such that every graph G embedded on S with face-width at least rho(sub H) contains H as a minor. The result implies that for H = C(sub k) by C(sub k) embedded on the torus, rho(sub H):=(3/2k) is the smallest possible value. The proof is based on deriving a result in the geometry of numbers. It implies that for any symmetric convex body K in (R squared), one has (lambda(sub 2)(K)) x (lambda(sub 1)(K star)) less than or equal to 3/2 and that this bound is smallest possible. ESA

N93-27542# Nationaal Inst. voor Kernfysica en Hoge Energiefysica, Amsterdam (Netherlands).

ON THE FERMIONIC HEISENBERG GROUP AND ITS Q-REPRESENTATIONS

Andrzej Frydryszak (Wroclaw Univ., Poland.) 26 Jun. 1992 13 p Sponsored by NUFFIC

(NIKHEF-H/92-11; ETN-93-93304) Avail: CASI HC A03/MF A01

A nonstandard way of representing the canonical anticommutation relations is presented. It is connected with a generalization of the Heisenberg group to a graded phase space. It is shown how Grassmann harmonic analysis can be performed and what are the Q representations of such a generalized Heisenberg group. The Schroedinger and Bargmann-Fock realizations are shown to exist. Grassmann-Hermite polynomials are obtained via the generalized Bargmann transform and new Grassmann-Laguerre polynomials are introduced. ESA

N93-27550# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.

ON TRANSFINITE ABSTRACT REDUCTION SYSTEMS

J. R. Kennaway (East Anglia Univ., Norwich, England.) Jan. 1992 15 p Sponsored in part by Commission of the European Communities and Netherlands Organization for Applied Scientific Research

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(CWI-CS-R9205; ETN-93-93218) Copyright Avail: CASI HC A03/MF A01

The notion of an abstract reduction system to allow transfinite reductions is generalized: reduction sequences of any original length. An ultrametric is introduced on the set of objects and a measure is introduced on the reduction steps, by analogy with the ultrametric on the space of finite and infinite terms and a measure of depth of a redex in a term. The notion of strongly convergent reduction sequence carries over to the abstract setting. It is found that while the concepts of strong normalization have natural generalizations to the transfinite case, most of the known theorems relating these properties no longer hold. Some axioms that might be imposed on transfinite abstract reduction systems are considered. ESA

N93-27582# Rome Univ. (Italy). Dipt. di Fisica.

BERRY'S PHASE FOR NON-CONSERVATIVE SYSTEMS

R. Mignani (Institute for Basic Research, Palm Harbor, FL.) 22 Nov. 1990 29 p Presented at the 5th International Conference on Hadronic Mechanics and Nonpotential Interactions, Cedar Falls, IA, 13-17 Aug. 1990 Submitted for publication

(SSCL-Preprint-767; ETN-93-93657) Avail: CASI HC A03/MF A01

Topics of geometrical phases for nonconservative systems are reviewed. Different approaches are considered: the biorthogonal state approach; the method based on density matrices; and the Lie-isotopic method. The resulting Berry's phase obtained by all these methods exhibits common features: it is complex and contains both a time dependent and a path dependent part. Most of the results found for the Hermitian Berry phase hold true for the nonhermitian one. Adiabaticity is not a necessary condition for the generation of a geometrical phase. ESA

N93-27607# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.

CLASSIFICATION OF MINIMAL GRAPHS OF GIVEN FACE-WIDTH ON THE TORUS

Alexander Schrijver (Amsterdam Univ., Netherlands.) Apr. 1992 17 p

(CWI-BS-R9203; ETN-93-93243) Copyright Avail: CASI HC A03/MF A01

For any graph G embedded on the torus, the face-width r(G) of G is the minimum number of intersections of G and C, where C ranges over all nonnullhomotopic closed curves on the torus. G is called r-minimal if r(G) is equal to or greater than r and r(G prime) is smaller than r for each proper minor G prime of G. The r-minimal graphs are classified by means of certain symmetric integer polygons in the plane R (the set of real numbers) squared. Up to a certain natural equivalence, the number of r-minimal graphs in the torus is equal to 1/6 r cubed + 5/6 r if r is odd and to 1/6 r cubed + 4/3 r if r is even. ESA

N93-27608# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.

GRAPHS ON THE TORUS AND GEOMETRY OF NUMBERS

Alexander Schrijver (Amsterdam Univ., Netherlands.) Apr. 1992 13 p

(CWI-BS-R9204; ETN-93-93244) Copyright Avail: CASI HC A03/MF A01

It is shown that if G is a graph embedded on the torus S and each nonnullhomotopic closed curve on S intersects G at least r times, then G contains at least the lower integer part of (3/4 r) pairwise disjoint nonnullhomotopic circuits. The factor 3/4 is best possible. It is proven by showing the equivalence of this bound to a bound in the two dimensional geometry of numbers. To show the equivalence, integer norms are studied such that norm(sign) of x is an integer for each integer vector x are studied. In particular, it is shown that each integer norm in two dimensions has associated with it a graph embedded on the torus, and conversely. ESA

N93-27615# Lawrence Livermore National Lab., CA.

CURVILINEAR GEOMETRY TRANSPORT DISCRETIZATIONS IN THE THICK DIFFUSION LIMIT

T. S. Palmer (Michigan Univ., Ann Arbor.) and M. L. Adams (Texas A&M Univ., College Station.) Jan. 1993 14 p Presented at the International Topical Meeting on Mathematical Methods and Supercomputing in Nuclear Applications (M/C+SNA 1993), Karlsruhe, Germany, 19-23 Apr. 1993

(Contract W-7405-eng-48)

(DE93-007109; UCRL-JC-111847; CONF-930404-6) Avail: CASI HC A03/MF A01

We evaluate the accuracy of 1-D spherical and 2-D cylindrical geometry transport discretizations in thick diffusive regions by means of a matrix asymptotic analysis. We show that two methods, 'simple' corner balance and a 'fully-lumped' discontinuous finite element method, are accurate, both in the interior of these regions and on boundaries. We give numerical results to illustrate our findings. DOE

N93-27621# Los Alamos National Lab., NM.

DIFFUSION-ACCELERATED SOLUTION OF THE 2-D S(SUB N) EQUATIONS WITH BILINEAR-DISCONTINUOUS DIFFERENCING

J. E. Morel, J. E. Dendy, Jr., and T. A. Wareing 1993 13 p Presented at the International Topical Meeting on Mathematical Methods and Supercomputing in Nuclear Applications (M&C+SNA 1993), Karlsruhe, Germany, 19-23 Apr. 1993

(Contract W-7405-eng-36)

(DE93-008793; LA-UR-93-293; CONF-930404-7) Avail: CASI HC A03/MF A01

A new diffusion-synthetic acceleration scheme is developed for solving the 2-D S(sub n) equations in X-Y geometry with bilinear-discontinuous finite-element spatial discretization. This method differs from previous

methods in that it is unconditionally efficient for problems with isotropic or weakly anisotropic scattering. Computational results are given which demonstrate this property. DOE

N93-27627# Brookhaven National Lab., Upton, NY.
THE METHOD OF MINIMAL NORMAL FORMS
S. R. Mane and W. T. Weng 1992 15 p Presented at the Stability of Particle Motion in Storage Rings, Upton, NY, 18-24 Oct. 1992
(Contract DE-AC02-76CH-00016)
(DE93-008060; BNL-48455; CONF-921077-1) Avail: CASI HC A03/MF A01

Normal form methods for solving nonlinear differential equations are reviewed and the comparative merits of three methods are evaluated. The concept of the minimal normal form is explained and is shown to be superior to other choices. The method is then extended to apply to the evaluation of discrete maps of an accelerator or storage ring. Such an extension, as suggested in this paper, is more suited for accelerator-based applications than a formulation utilizing continuous differential equations. A computer code has been generated to systematically implement various normal form formulations for maps in two-dimensional phase space. Specific examples of quadratic and cubic nonlinear fields were used and solved by the method developed. The minimal normal form method shown here gives good results using relatively low order expansions. DOE

N93-27644# Naval Postgraduate School, Monterey, CA. Dept. of Mathematics.
SOME INVERSE PROBLEMS FOR JACOBI AND ARROW MATRICES Technical Report, Jul. - Sep. 1992
Carlos Borgeds, Ruggero Frezza, and William B. Gragg 13 Oct. 1992 14 p
(AD-A262336; NPS-MA-93-002) Avail: CASI HC A03/MF A01

We consider the problem of reconstructing Jacobi matrices and real symmetric arrow matrices from two eigenpairs. Algorithms for solving these inverse problems are presented. We show that there are reasonable conditions under which this reconstruction is always possible. Moreover, it is seen that in certain cases reconstruction can proceed with little or no cancellation. The algorithm is particularly elegant for the tridiagonal matrix associated with a bidiagonal singular value decomposition. DTIC

N93-27691# New York Univ., New York. Inst. of Mathematical Sciences.
WAVELET LOCAL EXTREMA APPLIED TO IMAGE PROCESSING Final Report, 1 Nov. 1989 - 31 Oct. 1992
Stephane Mallat Dec. 1992 7 p
(Grant AF-AFOSR-0040-90)
(AD-A262362; AFOSR-93-0184TR) Avail: CASI HC A02/MF A01

The research project had two components. In the first part, we developed a numerical method based on the wavelet transform for the solution of partial differential equations. Singularities and sharp transitions in solutions of partial differential equations model important physical phenomena, which are hard to simulate with conventional numerical methods. We introduced a numerical scheme based on the orthogonal wavelet transform that adapts the computational resolution in space and time to the regularity of the solution. This scheme saves computations by concentrating the computational effort in regions where singularities or sharp transitions occur. It has been tested on the Burgers equation. DTIC

N93-27868# Groningen Rijksuniv. (Netherlands). Dept. of Mathematics.
ON RANKS OF TWISTS OF ELLIPTIC CURVES AND POWER-FREE VALUES OF BINARY FORMS
C. L. Stewart and J. Top (Waterloo Univ., Ontario.) 1992 42 p Sponsored in part by Killam Research Fellowship
(Grant NSERC-A3528)
(W-9213; ETN-93-93336) Avail: CASI HC A03/MF A01

Let E be an elliptic curve over the set Q, and the rank of E means the rank of the group of rational points of E: the behavior of the rank as twists of a given elliptic curve over Q are run over is studied. That is, attention is restricted to families of elliptic curves defined over Q which are isomorphic over the set C. There are families of quadratic, cubic, quartic and sextic twists. Previous results are reviewed and the aim of the study is to generalize these results and to remove the dependence on the parity conjecture. Further, a positive response is given to a question posed as to whether there are positive exponents associated to functions counting the number of twists of an elliptic curve E with ranks larger than 2. ESA

N93-27869# Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
POLYNOMIAL SYSTEMS WITH CENTERS AND LIMIT CYCLES
Robert E. Kooij and Andre Zegeling 1992 17 p
(Rept-92-38; ETN-93-93337) Copyright Avail: CASI HC A03/MF A01

Polynomial systems on the plane with coexisting centers and limit cycles are considered. The uniqueness of limit cycles in these cases is studied and new configurations in cubic systems are presented by using symmetry principle. An example of an integrable quartic system with a unique limit cycle and a center is given. The existence in a cubic system of three homoclinic separatrix connections through a singularity, two of which contain a focus and one a center, is proved with the use of perturbation techniques of Hamiltonian systems. ESA

N93-27883# Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
VALIDITY OF APPROXIMATIONS FOR TIME PERIODIC SOLUTIONS OF A FORCED NON-LINEAR HYPERBOLIC DIFFERENTIAL EQUATION
C. J. Blom and A. H. P. vanderBurgh 1992 26 p
(Rept-92-47; ETN-93-93136) Copyright Avail: CASI HC A03/MF A01

Time periodic solutions for a special weakly nonlinear wave equation with positive damping and a forcing term are studied. Special attention is paid to the case of full resonance where for the time periodic solutions, existence, uniqueness, and analyticity with respect to the small parameter epsilon is demonstrated. A Maple computer algebra program to compute the formal approximations for the time periodic solution is given in appendix. ESA

N93-27916# Leiden Univ. (Netherlands). Applied Mathematics Div.
LINEAR STABILITY ANALYSIS IN THE NUMERICAL SOLUTION OF INITIAL VALUE PROBLEMS
J. L. M. vanDorsselaer, J. F. B. M. Kraaijevanger, and M. N. Spijker Aug. 1992 40 p Submitted for publication Sponsored by Netherlands Organization for Scientific Research, and Royal Netherlands Academy of Arts and Sciences
(TW-92-07; ETN-93-93147) Avail: CASI HC A03/MF A01

The general problem of establishing upper bounds for the norms of the nth powers of square matrices is addressed. The focus is on upper bounds that grow only moderately (or stay constant) when n, or the order of the matrices, increases. The so called resolvent condition, occurring in the famous Kreiss matrix theorem, is a classical tool for deriving such bounds. Recently the classical upper bounds known to be valid under Kreiss's resolvent conditions were improved and generalizations of this resolvent condition were considered so as to widen the range of applications. The main purpose of this study is to review and extend some of these new developments. The upper bounds for the powers of matrices discussed in the study are intimately connected with the stability analysis of numerical processes for solving initial (boundary) value problems in ordinary and partial linear differential equations. This connection is highlighted. Numerical illustrations in the solution of a simple initial boundary value problem for a partial differential equation are given in conclusion. ESA

N93-27917# Leiden Univ. (Netherlands). Applied Mathematics Div.
TWO COUNTEREXAMPLES RELATED TO THE KREISS MATRIX THEOREM
J. F. B. M. Kraaijevanger Aug. 1992 9 p Submitted for publication Sponsored by Royal Netherlands Academy of Arts and Sciences
(TW-92-08; ETN-93-93148) Avail: CASI HC A02/MF A01

The modern version of the Kreiss matrix theorem states that the norm of A to the nth power is less than or equal to esK (for all n greater than or equal to 0) if A is an s by s matrix satisfying a resolvent condition with respect to the unit disk with constant K. A study showing that for any fixed K greater than or equal to pi + 1 that the upper bound esK is sharp in the sense that a linear dependence on the dimension s is the best possible. An analogous result is obtained for the continuous version of the Kreiss matrix theorem, which states that the norm of exp(tA) is less than or equal to esK (for all t greater than or equal to 0) if A is an s by s

matrix satisfying a resolvent condition with respect to the left half plane with constant K. ESA

N93-27931# Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
BIFURCATION OF LIMIT CYCLES IN A PARTICULAR CLASS OF QUADRATIC SYSTEMS WITH TWO CENTRES
W. T. vanHorssen and R. E. Kooij 1992 43 p
(Rept-92-43; ETN-93-93338) Copyright Avail: CASI HC A03/MF A01

A contribution to solving Hilbert's 16th problem regarding the maximum number of limit cycles in a polynomial system of differential equations is presented. Within the class of quadratic perturbations, it is shown analytically or numerically how many limit cycles can be bifurcated at the first order out of the periodic orbits nested around the center point in (0, 0) or nested around the center point in (0, 1/n) of the quadratic system x(dotted) = -y + n(y(exp 2)), y(dotted) = x - xy with n greater than 0 and less than 1. ESA

N93-27932# Technische Univ., Delft (Netherlands). Dept. of Technical Mathematics and Informatics.
FINITE ELEMENT MESH GENERATION FROM CSG MODELS Ph.D. Thesis
Edwin Boender 1992 176 p Sponsored by Rijkswaterstaat, Netherlands
(ETN-93-93614) Avail: CASI HC A09/MF A02

A description of techniques for FE (Finite Element) mesh generation from CSG (Constructive Solid Geometry) models and their implementation is given. The results obtained with the implemented techniques are described and discussed. The starting point is a solid model specified with CSG, and a mesh density function controlling the size of the finite elements derived from the model. A BRep (Boundary Representation) is derived with a boundary evaluation procedure that uses a dual representation (algebraic and rational polynomial parametric) for the faces of the primitives of the CSG model. Meshing the resulting BRep was divided into two steps: triangulating the faces of the BRep; and deriving a tetrahedral mesh from this triangulation (discussed but not implemented). ESA

N93-27940# Technische Univ., Delft (Netherlands).
A RESOLUTION METHOD FOR SOME SYSTEMS OF MODAL LOGIC Ph.D. Thesis
Rudolf Sommerhalder 1992 177 p
(ISBN-90-9005125-2; ETN-93-93620) Copyright Avail: CASI HC A09/MF A02

The possibility of extending the method of resolution to modal logic is studied. The well known modal systems K, D, T, S(sub 4) and S(sub 5) are considered, both the proposition and the predicate logics, and a system of resolution is defined for them. The system S(sub 5) is only considered for propositional case. The resolution systems consist of two types of rules: resolution rules, meaning classical rules, which deal with the non modal operators, and modal rules, which handle the model operators (square) en (diamond); simplification rules. The modal resolution rules are the same for all systems involved apart from the system K that has one rule fewer. The simplification rules depend much more strongly on the modal system involved. The resolution system defined by these rules is shown to be sound and complete; modal resolution rules for the predicate logic systems are similar to those used in proposition systems; a new class of model interpretations which consists of standard Kripke models (no queer worlds) extended with explicit translators between worlds is defined; and, based on terms that include translation symbols, Herbrand interpretations are developed and for each modal systems involved, a formula is proved to be consistent if and only if it has a Herbrand model. ESA

N93-27991# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.
MATHEMATICAL MORPHOLOGY AS A TOOL FOR SHAPE DESCRIPTION
Henk J. A. M. Heijmans Sep. 1992 27 p Presented at the Shape in Picture Workshop, Driebergen, Netherlands, 7-11 Sep. 1992
(CWI-BS-R9216; ETN-93-93823) Copyright Avail: CASI HC A03/MF A01

Mathematical morpholoIgy is an approach in image processing based on geometrical concepts such as transformation groups and metric spaces. As such, it is well suited for the extraction of information about the shape of the various parts in a scene. An overview of some better or less known morphological techniques (for example skeletonization, granulometric analysis) for the description and decomposition of shape is presented. ESA

N93-27992# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.
INTEGRAL SOLUTION TO SYSTEMS Ax LESS THAN OR EQUAL TO b
J. C. dePina and A. Schrijver (Amsterdam Univ., Netherlands.) Sep. 1992 7 p
(Grant GR-90/1173-2)
(CWI-BS-R9217; ETN-93-93824) Copyright Avail: CASI HC A02/MF A01

Let A be an integral m by n matrix satisfying summation notation(sup n)(sub j = 1) length a(sub ij) is less than or equal to 2 for all i = 1 ,...,m and b an integral m vector. It is shown that if Ax is less than or equal to b has an integral solution then every half-integral solution of Ax is less than or equal to b can be rounded to an integral solution. Moreover, an integral solution can be found with the same complexity as the single source problem. ESA

N93-27993# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.
ODD PATHS AND ODD CIRCUITS IN PLANAR GRAPHS WITH TWO ODD FACES
Bert A. M. H. Gerards Sep. 1992 11 p
(CWI-BS-R9218; ETN-93-93825) Copyright Avail: CASI HC A03/MF A01

The following result is proved: let G be a planar graph with at most two odd faces and let S be the collection of nodes in G with degree 1; if all the nodes not in S have an even degree, then the maximum number pairwise disjoint odd circuits and odd S paths is equal to the minimum size of a collection of edges meeting each odd circuit and each odd S path. The result implies that if a graph G contains a node v such that if v is deleted a planar graph with at most two odd faces is obtained, then G is weakly bipartite: the odd circuits in G have the weak max-flow min-cut property. ESA

N93-27998# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
A SIMPLE PROOF OF CONFLUENCE FOR WEAKLY ORTHOGONAL COMBINATORY REDUCTION SYSTEMS
Femke vanRaamsdonk Aug. 1992 26 p Sponsored by Netherlands Organization for Scientific Research
(CWI-CS-R9234; ETN-93-93832) Copyright Avail: CASI HC A03/MF A01

Combinatory Reduction Systems (CRS's) are term rewriting systems in which binding structures for variables are presented. Metavariables ranging over the set of terms are equipped with a fixed arity. As a consequence of extensions, various substitution mechanisms can be expressed: besides first order term rewriting systems also lambda calculus, extensions of lambda calculus, typed lambda calculi, and proof normalizations fit in the framework of CRS's. Confluence of orthogonal CRS's were proved by Klop. A much shorter, proof of conclunce for weakly orthogonal CRS's is presented. The proof of confluence gives rise to an extended notion of development, called 'superdevelopment'. Superdevelopments are proved to be finite for both orthogonal term rewriting systems and lambda calculus, thus generalizing the well known finite developments theorem. ESA

N93-28002# Universiteit Twente, Enschede (Netherlands). Dept. of Applied Mathematics.
SOLUTIONS OF THE ARE IN TERMS OF THE HAMILTONIAN FOR RIESZ-SPECTRAL SYSTEMS
C. R. Kuiper and J. J. Zwart Jun. 1992 21 p
(MEMO-1054; ETN-93-93839) Avail: CASI HC A03/MF A01

An investigation of the relation between the eigenvectors of the Hamiltonian and solutions of the Algebraic Riccati Equations (ARE) is presented. Restriction is made to the case where the Hamiltonian is a

Riesz spectral operator on an infinite dimensional Hilbert space. A general form of all possible solutions of the ARE is presented. Conditions for the existence of self-adjoint, nonnegative, and stabilizing solutions are also given. Some results concerning Riesz bases are proved. ESA

N93-28003# Universiteit Twente, Enschede (Netherlands). Dept. of Applied Mathematics.
ON PARTITIONS INTO UNEQUAL SQUARES AND RELATED PROBLEMS
F. Goebel May 1992 9 p
(MEMO-1055; ETN-93-93840) Avail: CASI HC A02/MF A01

The problem of partitioning a number into unequal qth powers is considered. The problem is solved for q = 2 and q = 3: a proof that each sufficiently large number has a partition into unequal squares and a partition into unequal cubes is given ('Numbers' are understood to be natural numbers). A conjecture of the analogous result for higher powers is given. Each sufficiently large number is conjectured to have a partition into 5 different squares, and it is shown that the number 5 cannot be replaced by 4. ESA

N93-28011# Universiteit Twente, Enschede (Netherlands). Dept. of Applied Mathematics.
A GROUP-THEORETICAL SETTING FOR SOME INTERSECTING SPERNER FAMILIES
Peter L. Erdoes, Ulrich Faigle, and Walter Kern Jun. 1992 21 p
(MEMO-1060; ETN-93-93842) Avail: CASI HC A03/MF A01

Using a group theoretical approach, some Erdos-Ko-Rado-type results for certain Sperner families of chains and antichains in partial orders are derived. In particular, Bollobas type inequalities for arbitrary Sperner families of interesecting affine subspaces and special intersecting Sperner families in generalized Boolean algebras are established. ESA

N93-28064# Utrecht State Univ. (Netherlands). Dept. of Computer Science.
CONGRUENCES AND QUOTIENTS IN CATEGORIES OF ALGEBRAS
Nico Verwer Jun. 1992 21 p
(RUU-CS-92-23; ETN-93-93292) Avail: CASI HC A03/MF A01

A study addressing a category theoretical description of quotient algebras is presented. Equational specifications can be implemented by quotient algebras. A categorical description of algebraic specification should include quotient algebras in such a way that it can serve as a guide in building algebraic specification systems. A new construction which does exactly this, and an example of how it could be used are given. This construction is simple, but still applicable in practical situations. ESA

N93-28065# Utrecht State Univ. (Netherlands). Dept. of Computer Science.
SPARSE ARRANGEMENTS AND THE NUMBER OF VIEWS OF POLYHEDRAL SCENES
M. deBerg, D. Halperin (Tel-Aviv Univ., Israel.), M. Overmars, and M. vanKreveld Jun. 1992 18 p Sponsored by EEC/ESPRIT, and Netherlands Organization for Scientific Research
(RUU-CS-92-24; ETN-93-93293) Avail: CASI HC A03/MF A01

Several instances of the so called 'aspect graph' problem are studied. Given a collection of n low degree algebraic surface patches in 3-space with the property that any vertical line stabs at most k of them, the maximum combinatorial complexity, D(n, k), of the entire arrangement that they induce, is to be determined. It is shown that D(n, k) = Theta(n(sup 2)(k)). This result is extended to collections of hypersurfaces in 4-space and to collections of (d - 1) simplices in d space. These results are applied to obtain upper bounds on the maximum number of views of a polyhedral terrain consisting of n edges and vertices. The bounds are O(n)(sup 4)(lambda(sub 4)(n)) for views from infinity and O(n(sup 7)(lambda(sub 4))(n)) for perspective views, where (lambda(sub 4))(n) is a near linear function related to Davenport-Schinzel sequences. Furthermore, these bounds are shown to be almost tight in the worst case. In the special case of an arrangement of k convex polyhedra having a total of n faces, the worst case complexity of the arrangement is Theta((n)(k(sup 2)). For the number of views of a collection of k convex polyhedra with a total of n faces, a bound of O((n(sup 4))(k(sup 2))) is shown for views from infinity and O((n(sup 6))(k(sup 3))) for perspective views. ESA

N93-28073# Universiteit Twente, Enschede (Netherlands). Dept. of Applied Mathematics.
A NOTE ON 2-FACTORS IN GRAPHS
Cornelis Hoede Aug. 1992 7 p
(MEMO-1064; ETN-93-93846) Avail: CASI HC A02/MF A01

A study of present theorems concerning hamiltonian graph theory is presented. A sufficient condition for connected graphs with a 2-factor to have a hamiltonian cycle is presented. ESA

N93-28074# Universiteit Twente, Enschede (Netherlands). Dept. of Applied Mathematics.
GRAPHS AND GAMES
Cornelis Hoede Aug. 1992 10 p
(MEMO-1065; ETN-93-93847) Avail: CASI HC A02/MF A01

A study to show the possibilities of using games for generating sets of graphs is presented. The concept of a cooperative game is extended by generalizing the range of the characteristic function. This opens the possibility to define games in which graphs correspond to solutions. Four examples of such games are given. ESA

N93-28082# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Numerical Mathematics.
NOTE ON THE PERFORMANCE OF DIRECT AND INDIRECT RUNGE-KUTTA-NYSTROEM METHODS
Nguten huu Cong (Hanoi Univ., Viet Nam.) Aug. 1992 13 p Sponsored by Amsterdam Univ., Netherlands
(CWI-NM-R9214; ETN-93-93812) Copyright Avail: CASI HC A03/MF A01

Predictor corrector iteration of Runge-Kutta-Nystroem (RKN) methods for integrating initial value problems for special second order ordinary differential equations are addressed. RKN correctors based on both direct and indirect collocation techniques are considered. The focus is on convergence factors and stability regions of the iterated RKN correctors. It turns out that the methods based on direct collocation RKN correctors possess smaller convergence than those based on indirect collocation RKN correctors. Both families of methods have sufficiently large stability boundaries for nonstiff problems. ESA

N93-28083# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Numerical Mathematics.
DIVISIBILITY PROPERTIES OF INTEGERS X AND K SATISFYING 1(EXP K) + 2(EXP K) +...+ (X - 1)(EXP K) = X(EXP K)
P. Moree (Leiden Univ., Netherlands.), H. J. J. teRiele, and J. Urbanowicz (Polish Academy of Sciences, Warsaw.) Aug. 1992 33 p Submitted for publication
(Grant NWO-611-307-019/018)
(CWI-NM-R9215; ETN-93-93813) Copyright Avail: CASI HC A03/MF A01

Based on congruences mod p and on properties of Bernoulli polynomials and numbers, several conditions are derived for x,k greater than or equal to 2 if they satisfy the diophantine equation 1(exp k) + 2(exp k) + ... + (x - 1)(exp k) = x(exp k). By using the results of experiments with these conditions in an SGI workstation, it is proved that x can not be divisible by any irregular prime less than 10,000 and that k is divisible by the least common multiple of all the integers less than or equal to 200. It is proved that x can not be divisible by any regular prime. ESA

N93-28085# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Analysis, Algebra and Geometry.
HYPERASYMPTOTICS AND THE STOKES' PHENOMENON
A. B. OldeDaalhuis Jun. 1992 14 p
(CWI-AM-R9206; ETN-93-93815) Copyright Avail: CASI HC A03/MF A01

Hyperasymptotic expansions were recently introduced by Berry and Howls. The expansions yield refined information by expanding remainders in asymptotic expansions. In a recent paper, a method is given for obtaining hyperasymptotic expansions of integrals that represent the confluent hypergeometric U-function. An extension of that method to neighborhoods of the so called Stokes lines is given. At each level, the remainder is exponentially small compared with the previous remainders. Two numerical illustrations confirm these exponential improvements. ESA

N93-28088# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.
GRAY-SCALE GRANULOMETRIES COMPATIBLE WITH SPATIAL SCALINGS
Eugene J. Kraus (Rochester Inst. of Tech., NY.), Henk J. A. M. Heijmans, and Edward R. Dougherty (Rochester Inst. of Tech., NY.) Jun. 1992 27 p
(CWI-BS-R9212; ETN-93-93819) Copyright Avail: CASI HC A03/MF A01

In the field of mathematical morphology, granulometries form the major tool for the computation of size distributions for binary images. A granulometry can be defined as a one parameter family of openings depending on a real parameter lambda greater than 0 such that the opening becomes more and more active as lambda increases. The granulometry is called a Euclidean granulometry if it is translation invariant and compatible with scalings. An important result due to Matheron states that simple Euclidean granulometries can be built by taking openings with convex compact structuring elements. A general extension of binary Euclidean granulometries to gray scale images using the notion of a spatial scaling (as opposed to umbral scaling) is described. The main result is that gray scale Euclidean granulometries with one structuring function can be built if and only if this function has a convex compact domain and is constant there (flat function). ESA

N93-28109# Technische Univ., Eindhoven (Netherlands).
ADAPTIVE FILTERING METHODS: ON METHODS TO USE A PRIORI INFORMATION IN ORDER TO REDUCE COMPLEXITY WHILE MAINTAINING CONVERGENCE PROPERTIES Ph.D. Thesis
Petrus Christianus W Sommen 1992 179 p
(ISBN-90-9005143-0; ETN-93-93583) Copyright Avail: CASI HC A09/MF A02

Some methods to use the available a priori information to reduce complexity, while maintaining convergence properties, are explored. A general introduction to adaptive filters is given and the used symbols and definitions are explained. Since block processing techniques play a central role in this thesis, a derivation and analysis of the well known and robust Block Normalized Least Means Square (BNLMS) algorithm are given. It is shown that for large filters (the acoustic echo canceller needs an adaptive transversal filter with 1000 to 2000 coefficients) the BNLMS algorithm can be implanted very efficiently in frequency domain. The following are then discussed: frequency domain adaptive filters; partitioned frequency domain adaptive filters and time domain adaptive filters. ESA

N93-28124# Groningen Rijksuniv. (Netherlands). Dept. of Mathematics.
ON THE BOGDANOV-TAKENS BIFURCATION FOR PLANAR DIFFEOMORPHISMS
H. W. Broer, R. Roussarie, and C. Simo 1992 14 p
(W-9202; ETN-93-93331) Avail: CASI HC A03/MF A01

The Bogdanov-Takens bifurcation for planar diffeomorphisms is studied. By a normal form procedure an approximation is obtained by the flow of a vector field having the classical bifurcation of the same name. Therefore, generic unfoldings of the map are studied, depending on two parameters. From the perturbation analysis it follows that the 'non-integrable' aspects of the map only occur in a small horn in the parameter plane. ESA

N93-28138# Groningen Rijksuniv. (Netherlands). Dept. of Mathematics.
EQUIVALENT CONDITIONS FOR THE SOLVABILITY OF THE INFINITE-DIMENSIONAL LQ-PROBLEM WITH UNBOUNDED INPUT AND OUTPUT OPERATORS
Bert A. M. vanKeulen 1992 29 p
(W-9209; ETN-93-93334) Avail: CASI HC A03/MF A01

Equivalent conditions for the solvability of the infinite horizon LQ (Linear Quadratic) problem with stability for a class of infinite dimensional systems with unbounded input and output operators are presented. In particular, these equivalent conditions are given in terms of a Riccati equation and a frequency domain inequality, just as in the finite dimensional case. ESA

N93-28139# Groningen Rijksuniv. (Netherlands). Dept. of Mathematics.
MIXED SPECTRA AND ROTATIONAL SYMMETRY
Henk W. Broer and Floris Takens 1992 32 p
(W-9212; ETN-93-93335) Avail: CASI HC A03/MF A01

A study which shows that persistent attractors with mixed spectrum do exist in the context of dynamical systems with rotational or SO(2) symmetry is presented. The bifurcations leading to SQP (Skew Quasi Periodic) attractors are also investigated, in particular a variation of the Hopf bifurcation between quasi periodic attractors of dimension two and three, the so called skew Hopf bifurcation. The interpretation of the power spectrum is discussed in terms of the concepts of ergodic theory and the relevant results in the ergodic theory of differential dynamical systems are recalled. The SQP attractors are constructed and their persistence is discussed. The bifurcational aspects of the SQP attractors are discussed in relation to the fact that they are nontrivial SO(2) bundles. The formal normal forms for skew Hopf bifurcations are constructed and analytical properties of this bifurcation, in particular of the invariant tori, are investigated. In the parameter direction the complexity of 'Chenciner bubbles' is seen to arise. Comments on various aspects of the dynamics, mainly based on numerical simulations, are given. ESA

N93-28146# Rome Univ. (Italy). Dept. of Physics.
INHOMOGENEOUS TODA LATTICE: ITS HIERARCHY AND DARHOUX-BACKLUND TRANSFORMATIONS
D. Levi (Istituto Nazionale di Fisica Nucleare, Rome, Italy.) and O. Ragnisco (Istituto Nazionale di Fisica Nucleare, Rome, Italy.) 25 Oct. 1990 8 p Submitted for publication Sponsored in part by NATO, Ministry of Public Education, Italy, and Inst. Nazionale di Fisica Nucleare, Rome, Italy
(SSCL-Preprint-762; ETN-93-93654) Avail: CASI HC A02/MF A01

A method on how to construct hierarchies of nonlinear differential difference equations with n-dependent coefficients is presented. A set of inhomogeneous Toda lattice equations which are associated with a discrete Schroedinger spectral problem whose potentials diverge asymptotically are presented. A new Darboux transformation which allows bounded solutions to be obtained is presented. These equations are applied to a specially simple case when the solution turns out to be expressed in terms of Hermite polynomials. ESA

N93-28156# Universiteit Twente, Enschede (Netherlands). Dept. of Applied Mathematics.
BALANCING FOR NONLINEAR SYSTEMS
Jacquelien Scherpen 14 Aug. 1992 20 p
(MEMO-1071; ETN-93-93853) Avail: CASI HC A03/MF A01

A method of balancing for nonlinear systems which is a kind of extension of balancing for linear systems, based on the input and output energy of a system, is presented. It is a local result, but gives more 'broad' results than obtained by just linearizing the system. Furthermore, the relation with balancing of the linearization is dealt with. The method is used as a tool for nonlinear model reduction and some of the properties of the reduced system are investigated. ESA

N93-28163# Rome Univ. (Italy). Dipt. di Fisica.
CONTINUOUS SYMMETRIES OF DISCRETE EQUATIONS
D. Levi (Montreal Univ., Quebec.) and P. Winternitz (Montreal Univ., Quebec.) 3 May 1990 4 p Submitted for publication Sponsored by NAT, Natural Science and Engineering Research Council of Canada, and FAR, Quebec, Canada
(SSCL-Preprint-738; ETN-93-93631) Avail: CASI HC A01/MF A01

The continuous Lie group and the Lie algebra techniques are extended to differential-difference equations, involving continuous dependent variables and both continuous and discrete independent ones. It is shown that the two dimensional Toda lattice has an infinite dimensional symmetry group with a Kac-Moody-Virasoro Lie algebra. ESA

N93-28164# Universiteit Twente, Enschede (Netherlands). Dept. of Applied Mathematics.
PROPER ELIMINATION OF LATENT VARIABLES
J. W. Polderman 14 Aug. 1992 11 p
(MEMO-1072; ETN-93-93854) Avail: CASI HC A03/MF A01

Behaviors in which two types of variables, manifest variables, the variables that are of interest to the user, and latent variables, the variables that are introduced to obtain a first representation, are distinguished, are considered. The problem is to find a representation of the manifest behavior, that is, elimination of the latent variables is required. If the original behavior can be represented by linear differential equations with constant coefficients,

then under certain conditions the same is true for the manifest behavior. These conditions are formulated and discussed. ESA

N93-28166# Utrecht State Univ. (Netherlands). Dept. of Computer Science.
CUTTINGS AND APPLICATIONS
Mark deBerg and Otfried Schwarzkopf Aug. 1992 14 p Sponsored by Netherlands Organization for Scientific Research
(RUU-CS-92-26; ETN-93-93858) Avail: CASI HC A03/MF A01

A general lemma on the existence of (1/r) cuttings of geometric objects in E(sup d) that satisfy certain properties is proved. This lemma is used to construct (1/r) cuttings of asymptotically optimal size for arrangements of line segments in the plane and arrangements of triangles in 3-space; for line segments in the plane, a cutting of size O(r + A(r(sup 2)))/(n(sup 2)) is obtained, and for triangles in 3-space the cutting has size O(r(sup 2))alpha(r) + A(r(sup 3))/(n(sup 3)). Here A is the combinatorial complexity of the arrangement. These results are used to obtain new results for several problems concerning line segments in the plane and triangles in 3-space. ESA

N93-28195# Rome Univ. (Italy). Dept. of Physics.
COMMUTATIVE DIAGRAMS AND TENSOR CALCULUS IN RIEMANN SPACES
R. Mignani (Istituto Nazionale di Fisica Nucleare, Rome, Italy.), E. Pessa, and G. Resconi (Universita Cattolica, Brescia, Italy.) 8 May 1990 20 p Submitted for publication
(SSCL-Preprint-741; ETN-93-93634) Avail: CASI HC A03/MF A01

The basic rules of tensor analysis on non-euclidean spaces are derived by means of the formalism of commutative diagrams. The different dimensionality of the diagrams involved gives rise to a hierarchy of the corresponding physical relations, starting from the simplest differential object covariant derivative to Bianchi identities and Einstein's equations. The coordinate transformations are introduced and the covariant derivative and the related Christoffel symbols are obtained. Second order commutators of covariant derivatives, and then the Riemann tensor, are obtained by means of the three dimensional (cubic) diagram. It is also shown how to picture the basic features of Riemannian geometry in terms of planar diagrams. A four-dimensional (hypercubic) diagram allows to get double commutators of covariant derivatives. The Jacobi identity is found by using a simple topological argument. The Bianchi identity and Einstein's field equations are derived. ESA

N93-28196# Rome Univ. (Italy). Dept. of Physics.
FINAL STATE INTERACTIONS FROM EUCLIDEAN CORRELATION FUNCTIONS
L. Maiani (Istituto Nazionale di Fisica Nucleare, Rome, Italy.) and M. Testa (Lecce Univ., Italy.) 25 May 1990 11 p Submitted for publication Sponsored in part by the Ministry of Public Education, Italy
(SSCL-Preprint-742; ETN-93-93635) Avail: CASI HC A03/MF A01

The three point Euclidean correlation functions are studied. A theorem relating their asymptotic behavior in Euclidean time and for infinite space volume to the threshold time like for factor and the scattering length are discussed. A relation between this approach and that in which scattering lengths are related to finite volume effects in energy levels is presented. ESA

N93-28387# Rome Univ. (Italy). Dept. of Physics.
INTEGRABLE SYMPLECTIC MAPS
M. Bruschi (Istituto Nazionale di Fisica Nucleare, Rome, Italy.), O. Ragnisco (Minnesota Univ., Minneapolis.), P. M. Santini (Academia Sinica, Beijing, China.), and Tu Gui-Zhang 7 Jun. 1990 29 p Submitted for publication Sponsored in part by the Ministry of Public Education, Italy, and Inst. Nazionale di Fisica Nucleare, Rome, Italy
(SSCL-Preprint-744; ETN-93-93637) Avail: CASI HC A03/MF A01

A survey of simplectic maps, their canonical formulation and integrability is given. A procedure to construct integrable simplectic maps starting from integrable evolution equations in lattices, is presented and illustrative examples are provided. The study aims at: elucidating what is meant by an integrable map, recalling and unifying notions and results introduced and discovered in different contexts and with different languages; and introducing a new large set of integrable maps, following a strategy which looks rather different from the one that characterizes some other investigations. ESA

N93-28441# Institut National de Recherche d'Informatique et d'Automatique, Valbonne (France). Programme 4: Robotique, Image et Vision.
ITERATIVE POINT MATCHING FOR REGISTRATION OF FREE-FORM CURVES
Zhengyou Zhang Apr. 1992 45 p
(INRIA-RR-1658; ETN-93-93900) Avail: CASI HC A03/MF A01

In general, geometric matching is a difficult unsolved problem in computer vision. In many practical applications, some a priori knowledge exists which considerably simplifies the problem. In visual navigation, for example, the motion between successive positions is usually either small or approximately known, but a more precise registration is required for environment modeling. An algorithm which meets this need is described. Objects are represented by free form curves, that is, arbitrary space curves of the type found in practice. A curve is available in the form of a set of chained points. The proposed algorithm is based on iteratively matching points on one curve to the closest points on the other. A least squares technique is used to estimate three dimensional motion from the point correspondences, which reduces the average distance between curves in the two sets. Both synthetic and real data were used to test the algorithm, and the results show that it is efficient and robust and yields an accurate motion estimate. The algorithm can be easily extended to solve similar problems such as two dimensional curve matching and three dimensional surface matching. ESA

N93-28442# Institut National de Recherche d'Informatique et d'Automatique, Valbonne (France). Programme 4: Robotique, Image et Vision.
USING PSEUDO KALMAN-FILTERS IN THE PRESENCE OF CONSTRAINTS APPLICATION TO SENSING BEHAVIORS
Thierry Vieville and Peter Sander May 1992 44 p
(INRIA-RR-1669; ETN-93-93901) Avail: CASI HC A03/MF A01

A generalization of the linear Kalman filter to nonlinear equations is introduced. The deterministic interpretation of this mechanism is discussed. The proposed algorithm is an alternative to the well known extended Kalman filter. A small experimental illustration is given. An application to sensory motor behaviors is proposed. The study is considered to be a simple description of a 'hack' to deal with nonlinearities and numerical instabilities in computer vision. ESA

N93-28447# Institut National de Recherche d'Informatique et d'Automatique, Valbonne (France). Programme 6: Calcul Scientifique, Modelisation et Logiciels Numeriques.
A KOLMOGOROV-SMIRNOV TYPE TEST FOR ERGODIC DIFFUSION PROCESSES [UN TEST DE TYPE KOLMOGOROV-SMIRNOV POUR PROCESSUS DE DIFFUSION ERGODIQUES]
Eric Fournie May 1992 30 p In FRENCH
(INRIA-RR-1696; ETN-93-93908) Avail: CASI HC A03/MF A01

A test of Kolmogorov-Smirnov type for ergodic diffusion processes, based on an estimate of large deviations probabilities for the supremum of the limit process of the empirical process, is presented. The results are extended to the case when some parameters in the drift are estimated during the same observation. An asymptotic speed for the rejection of the model when the drift is miss-specified is given. Complete examples are given, and the behavior of the test on numerical simulations is shown. ESA

N93-26872*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
REMOVING MALMQUIST BIAS FROM LINEAR REGRESSIONS
Frances Verter *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 339-340 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

N93-27347*# Universidad Nacional Autonoma de Mexico, Cuernavaca. Inst. de Ciencias Nucleares.
SYMMETRY ALGEBRA OF A GENERALIZED ANISOTROPIC HARMONIC OSCILLATOR
O. Castanos and R. Lopez-Pena *In* NASA. Goddard Space Flight

Center, Workshop on Harmonic Oscillators 1993 p 373-378 Sponsored in part by DGAPA (For primary document see N93-27311 10-74)
Avail: CASI HC A02/MF A04

N93-27348*# Naples Univ. (Italy). Dept. di Scienze Fisiche.
FERMION REALIZATION OF EXCEPTIONAL LIE ALGEBRAS FROM MAXIMAL UNITARY SUBALGEBRAS
A. Sciarrino *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 379-383 (For primary document see N93-27311 10-74)
Avail: CASI HC A01/MF A04

65 STATISTICS AND PROBABILITY

Includes data sampling and smoothing; Monte Carlo method; and stochastic processes.

N93-26631# Western Eco-Systems Technology, Inc., Cheyenne, WY.
STATISTICAL INFERENCE PROCEDURES FOR PROBABILITY SELECTION FUNCTIONS IN LONG-TERM MONITORING PROGRAMS Final Report
L. L. McDonald and B. F. J. Manly Mar. 1993 95 p Sponsored by Corvallis Environmental Research Lab.
(PB93-163012; EPA/620/R-93/004) Avail: CASI HC A05/MF A01

The report develops the theory and illustrates the use of selection functions to describe changes over time in the distributions of environmentally important variables at sites sampled as part of environmental monitoring programs. The first part of the report provides a review of the way that selection functions have been used up to the present time in the study of natural selection and resource selection by organisms in a population, assuming that variables influencing selection do no change during the course of the study. The proposal for using selection functions to describe population changes therefore requires a change in perspective. It then discusses the use of a parametric selection function based on the assumption of normally distributed data. It concerns the possible application of nonparametric kernel methods for estimating selection functions. An example of the use of selection functions to illustrate changes in the distribution of annual ring widths on Andean alder trees in Argentina in 1986 and 1989 is discussed. Finally, some recommendations concerning the use of selection functions in the context of Environmental Monitoring and Assessment Program (EMAP) is presented. NTIS

N93-27124*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
BASIC STATISTICAL ANALYSES OF CANDIDATE NICKEL-HYDROGEN CELLS FOR THE SPACE STATION FREEDOM
Thomas M. Maloney (Sverdrup Technology, Inc., Brook Park, OH.) and David T. Frate May 1993 76 p
(NASA-TM-106111; E-7762; NAS 1.15:106111) Avail: CASI HC A05/MF A01

Nickel-Hydrogen (Ni/H2) secondary batteries will be implemented as a power source for the Space Station Freedom as well as for other NASA missions. Consequently, characterization tests of Ni/H2 cells from Eagle-Picher, Whittaker-Yardney, and Hughes were completed at the NASA Lewis Research Center. Watt-hour efficiencies of each Ni/H2 cell were measured for regulated charge and discharge cycles as a function of temperature, charge rate, discharge rate, and state of charge. Temperatures ranged from -5 C to 30 C, charge rates ranged from C/10 to 1C, discharge rates ranged from C/10 to 2C, and states of charge ranged from 20 percent to 100 percent. Results from regression analyses and analyses of mean watt-hour efficiencies demonstrated that overall performance was best at temperatures between 10 C and 20 C while the discharge rate correlated most strongly with watt-hour efficiency. In general, the cell with back-to-back electrode arrangement, single stack, 26 percent KOH, and serrated zircar separator and the cell with a recirculating electrode arrangement, unit stack, 31 percent KOH, zircar separators performed best. Author (revised)

N93-27231# Technische Univ., Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
ELICITATION OF EXPERT KNOWLEDGE AND ASSESSMENT OF IMPRECISE PRIOR DENSITIES FOR LIFETIME DISTRIBUTIONS
F. P. A. Coolen May 1992 53 p
(MEMO-COSOR-92-12; ETN-93-93168) Avail: CASI HC A04/MF A01

Methods for elicitation of expert knowledge, to be used as information to assess imprecise prior densities for parameters of a model that describes the lifetime of a component are presented. Results on combination of elicited opinions are included. Which elicitation method is most useful depends on the nature of the problem and on experts. All methods that appear to be promising lead to imprecise probabilities for events, and these imprecise probabilities should be used for combination of expert opinions. Once elicitation yields lower and upper probabilities for a certain event, it is no longer important how these values were elicited. ESA

N93-27234# Technische Univ., Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
EXPERIMENTS: DESIGN, PARAMETRIC AND NONPARAMETRIC ANALYSIS, AND SELECTION
Paul vanderLaan Jun. 1992 57 p
(MEMO-COSOR-92-15; ETN-93-93171) Avail: CASI HC A04/MF A01

Some general remarks for experimental designs are made. The general statistical methodology of analysis for some special designs is considered. Statistical tests for some specific designs under normality assumptions are indicated. Nonparametric statistical analyses for some special designs are given. The method of determining the number of observations needed in an experiment is considered in the normal as well as in the nonparametric situation. The special topic of designing an experiment in order to select the best out of k(equal to or greater than 2) treatments is considered. ESA

N93-27236# Technische Univ., Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
ON BERNOULLI EXPERIMENTS WITH IMPRECISE PRIOR PROBABILITIES
F. P. A. Coolen Jun. 1992 29 p Presented at the 3rd International Conference on Practical Bayesian Statistics of the Institute of Statisticians, Nottingham, England, 8-11 Jul. 1992
(MEMO-COSOR-92-19; ETN-93-93175) Avail: CASI HC A03/MF A01

A situation where the prior distribution in a Bayesian treatment of a Bernoulli experiment is not known precisely is investigated. Imprecision for Bernoulli experiments is discussed for the case where the prior densities are defined in the form of intervals of measures, and a simple model with conjugate imprecise prior densities is used for ease of calculation in case of updating. Attention is focused on imprecision with regard to predictive probabilities. The main aim of the study is an analysis of imprecision, emphasizing the important relation between information and imprecision. Imprecision within the chosen model is compared to intuition, and it is shown that complete lack of prior information can be reasonably well represented. ESA

N93-27237# Technische Univ., Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
THE BEST VARIETY OR AN ALMOST BEST ONE? A COMPARISON OF SUBSET SELECTION PROCEDURES
Paul vanderLaan Jun. 1992 10 p
(MEMO-COSOR-92-22; ETN-93-93178) Avail: CASI HC A02/MF A01

Some aspects of subset selection are discussed and k varieties are given. The best variety is defined as the variety with the largest average yield per plot of common unit size. An almost best or an epsilon best variety is a variety with an average yield on a distance not larger than epsilon (equal to or greater than 0) from the best variety. Subset selection is considered for selection of the best variety, but also for selection of an epsilon-best variety. A comparison between these two selection goals is made by investigating the relative efficiency of subset selection of an epsilon best variety. An application in the field of variety testing is presented. ESA

N93-27276# Technische Univ., Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.

MAXIMUM IMPRECISION RELATED TO INTERVALS OF MEASURES AND BAYESIAN INFERENCE WITH CONJUGATE IMPRECISE PRIOR DENSITIES

F. P. A. Coolen Apr. 1992 17 p

(MEMO-COSOR-92-07; ETN-93-93163) Avail: CASI HC A03/MF A01

Following the concept of intervals of measures, some general results are derived for the maximum imprecision related to imprecise densities. A model for Bayesian inference with imprecise prior densities is proposed, where members of a conjugate family can be chosen to enable updating in a simple way. The model generalizes the former versions, as the lower and upper densities are no longer restricted to be equal up to a constant factor, and some results are derived for the maximum imprecision. Within the Bayesian framework, this general model allows wide classes of prior densities. The price for the greater generality of the model is that more hyperparameters need to be assessed. ESA

N93-27277# Technische Univ., Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.

A NOTE ON THE EFFECT OF VARYING ROUTING PROBABILITY ON TWO PARALLEL QUEUES WITH DYNAMIC ROUTING UNDER A THRESHOLD-TYPE SCHEDULING

I. J. B. F. Adan, J. Wessels (International Inst. for Applied Systems Analysis, Laxenburg, Austria.), and W. H. M. Zijm (Universiteit Twente, Enschede, Netherlands.) May 1992 9 p

(MEME-COSOR-92-08; ETN-93-93164) Avail: CASI HC A02/MF A01

An expression in the form of a product of powers for the state probabilities of a threshold type shortest queue problem is derived. It is demonstrated that this expression is essentially more complicated and has the form of an infinite sum of product of powers. In fact, only the first terms in the infinite sum are found. The resulting expression looks rather complicated. However, it is well suited for computation of the equilibrium probabilities as well as the relevant performance criteria. ESA

N93-27279# Technische Univ., Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.

SUBSET SELECTION: ROBUSTNESS AND IMPRECISE SELECTION

Paul vanderLaan May 1992 19 p

(MEMO-COSOR-92-10; ETN-93-93166) Avail: CASI HC A03/MF A01

Assume k (integer k equal to or greater than 2) independent populations are given. The associated independent random variables have distributions with an unknown location parameter. The goal is to select the best population, this is the population with largest value of the location parameter. Some distributional and robustness results for subset selection from normal populations are reviewed. Special attention is given to the probability of correct selection. Some distributional results are given. Explicit expressions for expectation and variance of the subset size using subset selection are presented. Some remarks concerning a generalized selection goal using subset selection are made. Instead of selecting precisely the best population, an imprecise selection can be applied, that is selection of the population in the neighborhood of the best population. The generalized subset selection goal is to select a non-empty subset of populations that contains at least one almost best population with a certain confidence level. For a collection of populations with an unknown location parameter an almost best population, or more accurately an epsilon best population, is defined as a population with location parameter, a distance less than or equal to epsilon (with epsilon equal to or greater than 0) from the maximal value of the location parameter for all populations. The selection of an almost best population is compared with the selection of the best one from an application point of view. Some efficiency results are presented. ESA

N93-27294# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Analysis, Algebra and Geometry.

AN INVITATION TO STRUCTURED (META)POPULATION MODELS

O. Diekmann (Leiden Univ., Netherlands.) Dec. 1991 16 p Sponsored in part by ARO

(CWI-AM-R9113; ETN-93-93250) Copyright Avail: CASI HC A03/MF A01

Some aspects of the formulation of mathematical models of physiologically structured populations are presented. The first part concentrates on the definition and the calculation of the basic reproduction ratio R(sub zero), the intrinsic rate of natural increase r and the asymptotic speed of propagation C(sub zero), for a rather general class of models for population growth, or decline, in a constant environment. Part two introduces the first order partial functional differential equations that arise when models for mechanisms at the individual level in variable environments are 'lifted' to the population level. The idea that nonlinearity results from feedback through the environment is illustrated in the context of energy budget models for Daphnia populations. A numerical technique is described. The third part is devoted to metapopulation models. It is argued that the formalism of the second part applies when local populations are considered as individuals characterized by colony size. Time scale arguments and special choices of model ingredients are used to derive tractable simplifications for which biologically relevant conclusions can be obtained. ESA

N93-27297# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Analysis, Algebra and Geometry.

THE SATURATING CONTACT RATE IN MARRIAGE- AND EPIDEMIC MODELS

J. A. P. Heesterbeek (Leiden Univ., Netherlands.) and J. A. J. Metz Mar. 1992 14 p

(CWI-AM-R9203; ETN-93-93253) Copyright Avail: CASI HC A03/MF A01

How to derive, by a mechanistic argument, an expression for the saturating contact rate of individual contacts in a population that mixes randomly is shown. The main assumption is that the individual interaction times are typically short as compared to the time scale of changes in, for example, individual type, but that the interactions yet make up a considerable fraction of the time budget of an individual. In special cases, an explicit formula for the contact rate is obtained. The result is applied to mathematical epidemiology and marriage models. ESA

N93-27298# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Analysis, Algebra and Geometry.

THE CUMULATIVE FORMULATION OF (PHYSIOLOGICALLY) STRUCTURED POPULATION MODELS

Odo Diekmann (Leiden Univ., Netherlands.), Mats Gyllenberg (Lulea Univ., Sweden.), J. A. J. Metz (Leiden Univ., Netherlands.), and Hoirst R. Thieme (Arizona State Univ., Tempe.) May 1992 12 p Sponsored in part by Bank of Sweden Tercentenary Foundation; Swedish Council for Forestry and Agricultural Research; and Swedish Cancer Foundation

(Grant NSF DMS-91-01979)

(CWI-AM-R9205; ETN-93-93255) Copyright Avail: CASI HC A03/MF A01

It is argued that a formulation of structured population models in terms of abstract renewal equations, combined with a feedback law, is at the same time natural, elegant, and technically advantageous compared to partial functional differential equations. General physiologically structured population models can be mathematically described by a renewal equation and a feedback law. The main advantage of such a formulation is that it avoids the use of unbounded operators (the generating family) for which a precise description of the domain of definition is a technically hard and unpleasant task, if possible at all. The plan is to use this formulation as the starting point for a qualitative theory for nonlinear problems, dealing in particular with stability and bifurcation. ESA

N93-27393# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.

A GENERAL MODEL FOR MAINTENANCE OF COMPLEX SYSTEMS

Peter R. deWaal Jan. 1992 20 p Sponsored by Koninklijke/Shell-Lab., Amsterdam, Netherlands

(CWI-BS-R9201; ETN-93-93241) Copyright Avail: CASI HC A03/MF A01

A semi-Markov reward model for a process system or installation with components that are subject to failure is described. The installation is represented as a directed graph with the nodes representing the components and the arcs representing the material flows between the components. Each component may have several failure modes. For each component two actions can be specified: a production and a maintenance decision. The production decision specifies the production level of the components, and this action depends on the current mode of the component. The maintenance decision specifies whether maintenance or repair is to be

performed on the component. This action depends on the current component's mode plus the current maintenance manpower allocation. The state of the system together with the decisions determine the dynamic behavior and the rewards, the latter of which is split into maintenance costs and production rewards. Some examples are included. ESA

N93-27659# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

IDENTIFICATION OF SIGNIFICANT OUTLIERS IN TIME SERIES DATA M.S. Thesis

Keri L. Robinson Mar. 1993 147 p

(AD-A262437; AFIT/GNE/ENP/93-M-7) Avail: CASI HC A07/MF A02

This thesis examines the feasibility of using least median of squares (LMS) procedure applied to a reweighted least squares (RLS) autoregression model to identify significant outliers in time series data. The time series were analyzed for data points that were outliers. In order to perform detailed analysis on an outlier, the analyst must be able to determine that an outlier data point is significantly different from normally distributed data. This thesis examines a new method for identifying these outliers. Data from the field were characterized and fit with time series models using an autoregressive reweighted least squares routine (ARRLS) derived from the LMS methodology. Various orders of autoregression were applied to the ARRLS method to determine an appropriate order for the model; resulting fit coefficients were tested for significance. Regression results from data taken at five sites are presented. By using an autoregressive order of one (AR(1)) applied to the ARRL-S, this method significantly improved outlier detection in the time series data over the recursive removal without regression (RRR) method currently in use. In addition to identifying the outliers found by RRR, the AR(1)-RLS method routinely identified four times as many outliers as AFTAC's RRR method. The AR(1)-RLS method is recommended as a complimentary procedure to the RRR method currently used. Recommendations for improvements to the AR(1)-RLS method are offered. DTIC

N93-27664# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

A COMPARISON OF VARIABLE SELECTION CRITERIA FOR MULTIPLE LINEAR REGRESSION: A SECOND SIMULATION STUDY M.S. Thesis

David P. Woollard Mar. 1993 222 p LIMITED REPRODUCIBILITY: More than 20% of this document may be affectd by microfiche quality

(AD-A262512; AFIT/GOR/ENS/93M-23) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

This thesis implements a variable selection method proposed by Alan J. Miller, and makes an extension of Ross J. Hansen's 1988 thesis research by comparing the methods he examined: Minimum MSE, Minimum Sp, and Minimum Cp with Miller's method. Response Surface methodology is employed with two performance measures: the percentage of correct variables in a model and the Theoretical Mean Squared Error of Prediction (TMSEP). Each technique is applied on generated data with known multicollinearities, variances, random predictors, and sample sizes. Both performance measures are computed for models selected under each technique. A full factorial design using each performance measure is set up to study the effectiveness of each variable selection technique with respect to the known data characteristics. Equations are generated which relate these data characteristics to each combination of performance measure and selection method. A graphical analysis of variance is performed to summarize each technique's performance. Miller's method is shown to be the best overall technique for selecting models with the highest percentage of correct variables. Minimum MSE, followed closely by Minimum Sp, selected models with the least TMSEP. DTIC

N93-27876# Technische Univ., Delft (Netherlands).

ON THE ASYMPTOTIC BEHAVIOR OF DISCRETE EVENTS SYSTEMS Ph.D. Thesis

Remco Edwin deVries 1992 115 p

(ISBN-90-74488-01-3; ETN-93-93603) Avail: CASI HC A06/MF A02

A study on Discrete Event Dynamic Systems (DEDS) concerned mostly with stochastic extensions is presented. Max-algebra is formally introduced and it is shown how it can be used to model a certain class of discrete event systems. Some results in this linear system theoretic approach on DEDS are reviewed. The concept of a random discrete event system is introduced. The asymptotic behavior of these systems is studied and a central limit result is presented. The asymptotic behavior of random DEDS is compared with the asymptotic behavior of deterministic DEDS. As an example of a discrete event system, a simple public transportation network is studied. An embedded Markov chain for the calculation of the average cycle time is studied. Boundedness and finiteness of the Markov chain are discussed, and an aggregation technique for the Markov chain in order to obtain an approximation of the average cycle time of random DEDS is discussed. This technique can be useful if the number of states of the Markov chain is large. ESA

N93-27905# Leiden Univ. (Netherlands). Applied Mathematics Div.

A RECURRENCE TYPE CHARACTERIZATION OF MU-EXPONENTIAL ERGODICITY FOR MARKOV PROCESSES

F. M. Spieksma 1992 24 p Sponsored by Netherlands Organization for Scientific Research

(TW-92-03; ETN-93-93145) Avail: CASI HC A03/MF A01

A characterization of mu-exponential ergodicity through the total expected mu-rewards until absorption into a finite set, for regular, standard, conservative Markov processes in a countable state space, is studied. This total expected reward condition is closely related to Tweedie's necessary and sufficient condition for exponential ergodicity, which uses the intensity matrix. The given condition can also be interpreted as a condition in the mu-norm of the taboo transition probability matrix. If the Markov process is uniformizable, the properties of the interest can be studied through an approximating discrete time Markov chain. The applicability of the total mu-reward condition is illustrated by its verification for the Jackson network with an arbitrary, but finite number of servers in each node. ESA

N93-27906# Leiden Univ. (Netherlands). Applied Mathematics Div.

OPTIMAL SERVER ASSIGNMENT IN THE CASE OF SERVICE TIMES WITH MONOTONE FAILURE RATES

Ger Koole 1992 10 p

(TW-92-04; ETN-93-93146) Avail: CASI HC A02/MF A01

A generalization of results of two types is presented. In Nain, (referenced), the optimality of the mu-c-rule is shown, while customers, after being served, can reenter in a possibly different class. In Hordijk and Ridder, DFR distributions are characterized in terms of their approximating phase type distributions. For a simpler sort of phase type distributions a similar result can be obtained for IFR distributions. Combinations and generalization of these results gives, for certain cost structures, the optimal policy for service time distributions with a monotone failure rate. ESA

N93-27907# Universiteit Twente, Enschede (Netherlands). Dept. of Applied Mathematics.

THE SET OF SUPER-STABLE MARRIAGES FORMS A DISTRIBUTIVE LATTICE

Boris Spieker Apr. 1992 10 p

(MEMO-1052; ETN-93-93192) Avail: CASI HC A02/MF A01

The stable marriage problem introduced by Gale and Shapley is addressed. An instance (P) consists of n men and n women each of whom has a totally ordered preference list of the opposite sex. A complete matching M in the bipartite men-women graph is called a marriage. A marriage is unstable if there is a man-woman pair not in M where both prefer each other to their current partners in M. A marriage is defined to be stable if it is not unstable. Replacing the total order of the preference lists of an instance of the stable marriage problem by arbitrary posets, it is shown that after adjusting the notion of stability to the new problem that the set of stable marriages still forms a distributive lattice. ESA

N93-27930# Groningen Rijksuniv. (Netherlands). Dept. of Mathematics.

MEASURABILITY OF OPERATORS

E. G. F. Thomas 1992 18 p

(W-9203; ETN-93-93332) Avail: CASI HC A03/MF A01

A smooth theory of random operators (a probability measure in a set of parameters, in this study, for definiteness operators in a separable Hilbert space) are presented. Important classes of linear operators in a separable Hilbert space, such as the closed operators, closed invertible operators, closed densely defined operators, self adjoint operators and other sets of operators, bounded or unbounded, defined in terms of spectra, are shown to be in a topology defined by the intermediary of the graphs, Lusin spaces, i.e., the underlying measurable spaces are standard Borel

spaces. The main theorem shows that the families the set (T(sub omega))(sub omega belongs to Omega) of self adjoint operators having a common core D, depend measurably on Omega if the maps omega to (T(sub omega)psi/Psi) are measurable for all Psi, Psi belonging to D. This is applied to show that self adjoint differential operators whose coefficients are measurable functions of the parameters omega, depend measurably on omega as operators. ESA

N93-28087# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.
FINITE INTERPOLATION OF RANDOM FIELDS
Kacha Dzhaparidze Jun. 1992 9 p
(CWI-BS-R9210; ETN-93-93817) Copyright Avail: CASI HC A02/MF A01

The best, in a mean square sense, linear interpolator for a stationary random field is constructed in terms of the orthogonal polynomials associated with the spectral distribution function of this field. The minimization problem of Toeplitz forms is addressed and the relationship with the original interpolation problem is indicated. ESA

N93-28089# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.
INCIDENCE AND LATTICE CALCULUS WITH APPLICATIONS TO STOCHASTIC GEOMETRY AND IMAGE ANALYSIS
A. J. Baddeley (Leiden Univ., Netherlands.) and H. J. A. M. Heijmans Jun. 1992 23 p Submitted for publication
(CWI-BS-R9213; ETN-93-93820) Copyright Avail: CASI HC A03/MF A01

Incidence between subsets is a basic concept of stochastic geometry and mathematical morphology. A formal generalization of incidence (and the dual motion of dominance) in the setting of complete lattices is discussed. Applications to mathematical morphology, random set theory, and combinatorial geometrical probability are discussed. Other practical applications to transmission microscopy, digital image discretization, and robot motion planning are outlined. The generalized incidence structure turns out to be equivalent to the established idea of a lattice and junction. Using this, many problems in stochastic geometry (Buffon-Sylvester problem, local knowledge, and overprojection effects) can be reformulated as lattice calculations. ESA

N93-28091# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.
BOOTSTRAPPING MULTIVARIABLE U-QUANTILES AND RELATED STATISTICS
R. Helmers and M. Huskova (Karlova Univ., Prague, Czechoslovakia.) Jul. 1992 13 p Sponsored in part by Netherlands Organization for Scientific Research
(CWI-BS-R9215; ETN-93-93822) Copyright Avail: CASI HC A03/MF A01

The asymptotic consistency of the bootstrap approximation of the vector of the marginal generalized quantiles of U statistics structure (multivariate U quantiles for short) is established. The asymptotic accuracy of the bootstrap approximation is also obtained. Extensions to smooth functions of marginal generalized quantiles, are given and some specific examples, such as the vector of marginal sample quantiles and the vector of marginal Hodges-Lehmann location estimators, are discussed. ESA

N93-28098# Rome Univ. (Italy). Dept. of Physics.
CORRELATION FUNCTIONS AND RELAXATION PROPERTIES IN CHAOTIC, DYNAMIC AND STATISTICAL MECHANICS
Massimo Falcioni, Stefano Isola (Florence Univ., Italy.), and Angelo Vulpiani (Aquila Univ., Italy.) 16 Jan. 1990 15 p Submitted for publication
(SSCL-Preprint-725; ETN-93-93626) Avail: CASI HC A03/MF A01

A derivation, for chaotic systems, for a general fluctuation/response relation is given. The connection between relaxation properties and correlation functions is discussed. The aim is to point out a problem which plays an important role both in statistical mechanics and in the ergodic approach to dynamical systems: the understanding of the relaxation properties of a system and its response to external perturbations in terms of the invariant features of its asymptotic probability distribution. ESA

N93-28120# Groningen Rijksuniv. (Netherlands). Dept. of Mathematics.
SOME LIMIT THEOREMS IN LOG DENSITY
Istvan Berkes (Hungarian Academy of Sciences, Budapest.) and Herold Dehling 1991 38 p
(Grant HNFSR-1905)
(W-9108; ETN-93-93328) Avail: CASI HC A03/MF A01

A systematic study of 'log' analogs of classical limit theorems of probability theory is presented. A general version of the a.s. central limit theorem and its functional version for independent, not necessarily identically distributed random variables, are proved. The 'log' analogs of the strong and weak laws of large numbers are investigated. An extension of Fisher's a.s. invariance principle to arbitrary independent and identically distributed sequences is given. ESA

N93-28193# Rome Univ. (Italy). Dept. of Physics.
LARGE DEVIATIONS THEORY AND STOCHASTIC GAUGE FIXING
G. Jona-Lasinio and C. Parrinello 7 May 1990 8 p Presented at the Ascona Conference on Stochastic Processes, Physics, and Geometry, 1988 Submitted for publication
(SSCL-Preprint-739; ETN-93-93632) Avail: CASI HC A02/MF A01

The Gribov ambiguity is investigated in the Landau gauge description. The euclidean version of a Yan-Mills theory with gauge group G = SU(N) is considered. The Zwanziger scheme for stochastic quantization is applied, in order to avoid free diffusion of the system along gauge orbits, and the equation obtained is analyzed in the semiclassical limit. The estimates in the semiclassical limit can be obtained by considering the behavior of the system when the noise is very small. ESA

N93-28400# Pennsylvania Univ., Philadelphia. Dept. of Electrical Engineering.
STATISTICAL TECHNIQUES FOR SIGNAL PROCESSING Final Report, 1 Nov. 1989 - 31 Oct. 1992
Saleem A. Kassam 12 Jan. 1993 10 p
(Grant AF-AFOSR-0050-90)
(AD-A262731; AFOSR-93-0201TR) Avail: CASI HC A02/MF A01

This report summarizes research accomplishments in the 3-year period Nov. 1, 1989 Oct. 31, 1992. The primary accomplishments were in the areas of (1) nonlinear and robust filters - order statistics and related filters, multivariate medians, analysis, and applications; (2) signal detection in non-Gaussian noise - asymptotic relative efficiency (ARE), quantization, distributed detection, nonparametric detection; and (3) nonlinear radial basis function networks in signal processing. Reference is made to 28 publications. DTIC

N93-28404# Naval Command, Control and Ocean Surveillance Center, San Diego, CA.
ON MODELING OF IF-THEN RULES FOR PROBABILISTIC INFERENCE
I. R. Goodman and H. T. Nguyen Feb. 1993 13 p
(AD-A262789) Avail: CASI HC A03/MF A01

We identify various situations in probabilistic intelligent systems in which conditionals (rules) as mathematical entities as well as their conditional logic operations are needed. In discussing Bayesian updating procedure and belief function construction, we provide a new method for modeling if-then rules as Boolean elements, and yet, compatible with conditional probability quantifications. DTIC

N93-28445# Institut National de Recherche d'Informatique et d'Automatique, Valbonne (France). Programme 4: Robotique, Image et Vision.
RESTORATION OF INCOMPLETE CONTOUR IMAGES USING MARKOV RANDOM FIELDS [RESTAURATION D'IMAGE DE CONTOURS INCOMPLETS PAR MODELISATION PAR CHAMPS DE MARKOV]
Sabine Urago, Marc Berthod, and Josiane Zerubia May 1992 82 p In FRENCH
(INRIA-RR-1688; ETN-93-93906) Avail: CASI HC A05/MF A01

An algorithm which allows the restoration of images with incomplete contours is described. Markov random fields and Gibbs distributions are used. In order to restore the contours, a few criteria which have to be optimized are defined. Deterministic (iterated conditional mode) or stochastic

relaxation (Gibbs sampler) algorithms generate a configuration in which the contours are completed. The study shows how to modify and extend the method proposed by J.L. Marroquin to enable the processing of real and noisy images. To illustrate this algorithm, several examples are given including synthetic, noisy, and real (indoors and SPOT satellite) images.
ESA

66 SYSTEMS ANALYSIS

Includes mathematical modeling; network analysis; and operations research.

N93-27278# Technische Univ., Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
UPPER AND LOWER BOUNDS FOR THE WAITING TIME IN THE SYMMETRIC SHORTEST QUEUE SYSTEM
Ivo J. B. F. Adan, Geer-Jan J. A. N. vanHoutum, and Jan vanderWal May 1992 20 p
(Memo-COSOR-92-09; ETN-93-93165) Avail: CASI HC A03/MF A01

The exponential symmetric shortest queue system is compared with two related systems: the shortest queue system with threshold jockeying; and the shortest queue system with threshold blocking. The latter two systems are easier to analyze and are shown to give tight lower and upper bounds respectively for the mean waiting time in the shortest queue system. The approach also gives bounds for the distribution of the total number of jobs in the system.
ESA

N93-27309# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.
A GLOBALLY GATED POLLING SYSTEM WITH SERVER INTERRUPTIONS, AND APPLICATIONS TO THE REPAIRMAN PROBLEM
O. J. Boxma (Tilburg Univ., Netherlands.), J. A. Weststrate (Tilburg Univ., Netherlands.), and U. Yechiali (Tel-Aviv Univ., Israel.) Apr. 1992 19 p
(CWI-BS-R9208; ETN-93-93248) Copyright Avail: CASI HC A03/MF A01

A repairman type problem modeled as a globally gated polling system with server interruptions, while providing a detailed analysis of cycle times, queue lengths, and waiting times, is investigated. The polling model is used as a vehicle to analyze and optimize a real maintenance process in which a single repairman is handling two types of maintenance. A closed form expression of the Laplace-Stieltjes transform is derived together with the first moment of the waiting rule distributions of the preventive and corrective maintenance requests at the various installations. Simple and easily implementable static and dynamic rules for optimal operation of the system are obtained. It is shown that for the so called elevator type polling scheme, mean waiting times of preventive maintenance jobs at all installations are equal.
ESA

N93-27396# Technische Univ., Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
ANALYSING E(SUB k)/E(SUB r)/c QUEUES
I. J. B. F. Adan, W. A. vandeWaarsenburg, and J. Wessels (International Inst. for Applied Systems Analysis, Laxenburg, Austria.) Jul. 1992 21 p
(Memo-COSOR-92-27; ETN-93-93183) Avail: CASI HC A03/MF A01

A system consisting of c parallel identical servers and a common queue is studied. The service times are Erlang-r distributed and the interarrival times are Erlang-k distributed. The service discipline is first come first serve. The waiting process may be characterized by (n(sub -1), n(sub 0), n(sub 1),...n(sub c)) where n(sub -1) represents the number of remaining arrival stages, n(sub 0) the number of waiting jobs and n(sub i), i = 1,...,c, the number of remaining service stages for server i. It is shown that the coefficients have a geometric form with respect to n(sub -1), n(sub 1),..., n(sub c). It is also shown how the factors may be found efficiently. A direct approach for solving the equilibrium equations rather than a generating function approach is used. The direct approach was inspired by previous work on the shortest queue problem in particular and the two dimensional random walk.
ESA

N93-27606# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.
APPROXIMATE ANALYSIS OF AN M/G/1 PRIORITY QUEUE WITH PRIORITY CHANGES DUE TO IMPATIENCE
Peter R. deWaal Jan. 1992 17 p Sponsored by Koninklijke/Shell-Lab., Amsterdam, Netherlands
(CWI-BS-R9202; ETN-93-93242) Copyright Avail: CASI HC A03/MF A01

The approximate analysis of an M/G/1 queue where low priority customers may flow over to become high priority customers due to impatience is discussed. The first approximation method uses a standard M/G/1 priority queue in which the arrival rates are adjusted according to an estimation of the fraction of overflowing customers. The second approximation method consists of a brute force calculation of the equilibrium distribution of the queueing system with phase type service time distributions, using the method of stages and truncation of the state space. A queueing model for corrective and preventive maintenance of a large number of components in a technical installation like, for instance, a plant at an oil refinery or an offshore platform is presented. For such an installation an estimation of the maintenance workload is made on the basis of among other things, design information of the installation, various repair strategies and operational regimes. This estimation should account for both unplannable or emergency maintenance jobs and plannable or preventive maintenance. The distinction is made between these two different types of jobs, corrective maintenance and preventive maintenance. Corrective maintenance corresponds to repair of components that have broken down, and preventive maintenance is performed on a component to prevent it from breaking down.
ESA

N93-27830# Strategic Defense Initiative Organization, Washington, DC.
MIDCOURSE SPACE EXPERIMENT (MSX) ENVIRONMENTAL ASSESSMENT Final Report
6 Mar. 1992 168 p
(AD-A262460; Rept-70-1-31) Avail: CASI HC A08/MF A02

This document presents an assessment of the potential environmental consequences of the development and subsequent operation of the MSX spacecraft and other related activities. Findings from the assessment determined no significant impact will result from conducting the MSX program.
DTIC

N93-28295# Los Alamos National Lab., NM.
VALUE OF SPACE DEFENSES
G. H. Canavan 29 Oct. 1992 6 p Presented at the Near Earth Objects (NEO) Workshop, Los Alamos, NM, Oct. 1992
(Contract W-7405-eng-36)
(DE93-003813; LA-UR-92-3648; CONF-9210237-2) Avail: CASI HC A02/MF A01

This report discusses the economic value of defenses against Near-Earth Object (NEO) impacts is bounded by calculating expected losses in their absence, which illustrates the contributions from NEO's of different sizes and the sensitivity of total expected losses to impact frequencies. For typical size distributions and damage of only a few decades duration, losses are most sensitive to small NEO's, and lead to defenses worth a few $M/yr. When the persistence of damage with NEO size is taken into account, that shifts the loss to the largest NEO's and greatly increases expected loss and values.
DOE

N93-27206 Technion - Israel Inst. of Tech., Haifa. Faculty of Aerospace Engineering.
A SIMPLIFIED DYNAMIC GAME MODEL FOR ANTI-MISSILE DEFENSE SCENARIOS
G. Silberman and J. Shinar *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 335-343 (For primary document see N93-27166 10-01)
Copyright Avail: Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel

N93-27209 Rafael Armament Development Authority, Haifa (Israel). Missile Div.
OPTIMIZATION OF CLOSED-LOOP TACTICS IN BALLISTIC DEFENSE-OFFENSE SCENARIOS

Moti Shefer *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics 20 Feb. 1992 p 363-367 (For primary document see N93-27166 10-01)
Copyright Avail: Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel

67 THEORETICAL MATHEMATICS

Includes topology and number theory.

N93-26673# Virginia Polytechnic Inst., Blacksburg.
ON THE OCTONIONIC NAHM EQUATIONS AND SELF-DUAL MEMBRANES IN 9 DIMENSIONS
M. P. Grabowski and Chia-Hsiung Tze Jul. 1992 12 p Presented at the 6th Symmetries in Science, Bregenz, Austria, 2-7 Aug. 1992
(Contracts DE-FG05-92ER-40709; DE-AS05-80ER-10713)
(DE93-007974; CONF-9208164-2) Avail: CASI HC A03/MF A01

We introduce an analog of the Nahm equations for the spatially constant Yang-Mills gauge fields in 8 dimensions. We show that they can be derived from the vanishing of an octonionic moment map. In the case when the gauge group is SU (infinity) the octonionic Nahm equations provide a self-duality condition for a membrane in 9 dimensional space-time. DOE

N93-27507# Nationaal Inst. voor Kernfysica en Hoge Energiefysica, Amsterdam (Netherlands).
ALGEBRAIC CONFORMAL FIELD THEORY
Juergen Fuchs (European Organization for Nuclear Research, Geneva, Switzerland.) Nov. 1991 18 p Presented at the 25th International Symposium on Elementary Particle Theory, Gosen, Germany, Sep. 1991 Submitted for publication
(NIKHEF-H/91-26; ETN-93-93294) Avail: CASI HC A03/MF A01

Some recent attempts to arrive at a more unified treatment of the algebraic and conformal field theory are reviewed. Two dimensional conformal field theories are described in terms of the algebraic theory of superselection sectors. Examples for various nontrivial structures, which are present in general two dimensional quantum field theory are presented. Many features of conformal theory are special versions of structures which are present in arbitrary two dimensional quantum field theories. It makes sense to describe two dimensional conformal field theories in the context of the algebraic theory of superselection sectors. While most of the results of the algebraic theory are rather abstract, conformal field theories offer the possibility to work out many formulae explicitly. Some explicit results for the level 1 so(N) WZW theories are presented. ESA

N93-27510# Nationaal Inst. voor Kernfysica en Hoge Energiefysica, Amsterdam (Netherlands).
SYMMETRIES AND MOTIONS IN MANIFOLDS
J. W. vanHolten and R. H. Rietdijk 1992 19 p Presented at the 28th Karpacz Winter School of Theoretical Physics, Poland, 1992 Sponsored by Stichting voor Fundamenteel Onderzoek der Materie, Netherlands
(NIKHEF-H/92-08; ETN-93-93301) Avail: CASI HC A03/MF A01

The relations between symmetries, Lie algebras, Killing vectors, and Noether's theorem are reviewed. The basic ideas are generalized to include velocity dependent coordinate transformations which lead to the concept of Killing tensors. Via their Poisson brackets these tensors generate an a priori infinite-dimensional Lie algebra. The nature of such infinite algebras is clarified using the example of flat space time. The formalism is extended to spinning space, which is parametrized also by Grassmann-valued vector variables. The equations for extremal trajectories describe the pseudo-classical mechanics of a Dirac fermion. The formalism is applied to solve for the motion of a pseudo-classical electron in Schwarzschild space time. ESA

N93-28101# Rome Univ. (Italy). Dept. of Physics.
NON-ISOSPECTRAL EXTENSION OF THE CHIRAL MODEL AND ITS GEOMETRY
D. Levi and A. Sym (Warsaw Univ., Poland.) 26 Apr. 1990 3 p Submitted for publication
(SSCL-Preprint-735; ETN-93-93629) Avail: CASI HC A01/MF A01

The purpose of the study is to introduce some new integrable model connected with the geometry of Bianchi surfaces. A system of coupled partial differential equations describing the geometry of a spectral class of hyperbolic surfaces (surfaces in E cubed of negative curvature) is investigated. Possible physical applications of this model are discussed. ESA

N93-28119# Groningen Rijksuniv. (Netherlands). Dept. of Mathematics.
THE COMMUTANT LIFTING THEOREM FOR CONTRACTIONS ON KREIN SPACES
Aad Dijksma, Michael A. Dritschel, Stefania A. M. Marcantognini, and Henk S. V. deSnoo 1991 17 p Sponsored in part by NSF, Foundation Gran Mariscal de Ayacucho, Venezuela, and Netherlands Organization for Scientific Research
(W-9107; ETN-93-93327) Avail: CASI HC A03/MF A01

A proof of the commutant lifting theorem for contractions on Krein spaces is given. This is done by associating to the data a suitable isometry V so that a solution of the lifting problem is obtained directly from a unitary Hilbert space extension of V. Furthermore, a bijective correspondence between the solutions and the family of all minimal unitary Hilbert space extensions of V is established. In the Hilbert space case the method is due to R. Arocena. ESA

N93-28121# Groningen Rijksuniv. (Netherlands). Dept. of Mathematics.
NOTES ON KREIN SPACES
J. Capelle and E. G. F. Thomas 1991 44 p
(W-9109; ETN-93-93329) Avail: CASI HC A03/MF A01

Motivated by the fact that Krein spaces occur naturally in connection with representations of groups, a summary of the basic properties of Krein spaces, and more generally complete metrizable inner product spaces, is given. In the case of group representations the indefinite inner product is invariant, but the auxiliary Hilbert inner products are not. This is the reason the subject is presented with an indefinite inner product rather than a Hilbert inner product as a starting point. The notion of G completion of a preKrein space is introduced and in some significant cases G completions are shown to be essentially unique. ESA

N93-28125# Groningen Rijksuniv. (Netherlands). Dept. of Mathematics.
THE COMMUTANT LIFTING THEOREM IN THE KREIN SPACE SETTING: A PROOF BASED ON THE COUPLING METHOD
S. A. M. Marcantognini 1992 13 p Sponsored by Foundation Gran Mariscal de Ayacucho, Venezuela, Netherlands Organization for Scientific Research, and Groningen Univ., Netherlands
(W-9208; ETN-93-93333) Avail: CASI HC A03/MF A01

A proof of the commutant lifting theorem for contractions of Krein spaces is given. This is done by adapting to the Krein space situation the Hilbert space proof based on the couplings of two contractions. Furthermore, a one to one correspondence between the contractive intertwining liftings and a family of isometric couplings is established. ESA

N93-28454# Stanford Univ., CA. Systems Optimization Lab.
COMPUTING MODIFIED NEWTON DIRECTIONS USING A PARTIAL CHOLESKY FACTORIZATION
A. Forsgren (Royal Inst. of Tech., Stockholm, Sweden.), P. E. Gill, and W. Murray Mar. 1993 16 p
(Contracts DE-FG03-92ER-25117; N00014-90-J-1242; NSF DDM-92-04547; NSF DDM-92-04208)
(DE93-009584; SOL-93-1) Avail: CASI HC A03/MF A01

The effectiveness of Newton's method for finding an unconstrained minimizer of a strictly convex twice continuously differentiable function has prompted the proposal of various modified Newton's methods for the nonconvex case. Line-search modified Newton's methods utilize a linear combination of a descent direction and a direction of negative curvature. If these directions are sufficient in a certain sense, and a suitable line-search is used, the resulting method will generate limit points that satisfy the second-order necessary conditions for optimality. We propose an efficient method for computing a descent direction and a direction of negative curvature that is based on a partial Cholesky factorization of the Hessian. This factorization not only gives theoretically satisfactory directions, but also requires only a partial pivoting strategy, i.e., the equivalent of only two rows of the Schur complement need be examined at each step. DOE

N93-27316*# Helsinki Univ. (Finland). Dept. of Theoretical Physics.
THE SU(2) ACTION-ANGLE VARIABLES
Demosthenes Ellinas *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 41-46 (For primary document see N93-27311 10-74)
Avail: CASI HC A02/MF A04

70 PHYSICS (GENERAL)

For precision time and time interval (PTTI) see *35 Instrumentation and Photography;* for geophysics, astrophysics or solar physics see *46 Geophysics, 90 Astrophysics,* or *92 Solar Physics.*

N93-28013# Universiteit Twente, Enschede (Netherlands). Dept. of Applied Mathematics.
A REPRESENTATION RESULT FOR NONLINEAR FILTER MAPS ON A WHITE NOISE FRAMEWORK
Ravi R. Mazumdar (Quebec Univ., Sainte-Foy.) and Arunabha Bagchi Jul. 1992 31 p Revised
(Grant NSERC-OGP-0042024)
(MEMO-1062; ETN-93-93844) Avail: CASI HC A03/MF A01

The nonlinear filtering model with additive white noise which is the identity map on H = L(sub 2)(the closed interval (0, T)) with standard Gauss measure thereon is considered. Using a representation result for maps which are continuous in a locally convex topology generated by semi-norms of nuclear operators on H, it is shown that when the signal process is the solution of a nonlinear diffusion equation whose drift is uniformly Lipschitz, the nonlinear filter map can be written as the composition of a nonlinear map (which does not depend on the observation) with a linear Hilbert-Schmidt operator acting on the observation. When the nonlinear drift term satisfies the Benes conditions, it is shown that the Hilbert-Schmidt operator corresponds to the filter arising from a linear, Gaussian problem. ESA

N93-28147# Universiteit Twente, Enschede (Netherlands). Dept. of Applied Mathematics.
ON RADON-NIKODYM DERIVATIVES OF FINITELY ADDITIVE MEASURES INDUCED BY NONLINEAR TRANSFORMATIONS ON HILBERT SPACE
Arunabha Bagchi and Ravi R. Mazumdar (Quebec Univ., Sainte-Foy.) Jul. 1992 31 p
(MEMO-1063; ETN-93-93845) Avail: CASI HC A03/MF A01

The issue of evaluating the Radon-Nikodym derivatives of finitely additive measures induced by nonlinear transformations of the type (I - M)(exp -1) on a Hilbert space H with standard Gauss measure thereom is studied. Under suitable conditions on the nonlinear map M, it is shown that the R-N derivative is given by a Jacobi type transformation. The R-N derivative for the process which satisfies a nonlinear differential equation driven by additive white noise (which is the identity map on H under Gauss measure) is then evaluated. In particular it is shown that this is the white noise analog of the Cameron-Martin formula with an additional term which when interpreted for paths in C(closed interval (0,T)) corresponds to the Wong-Zakai correction term. ESA

N93-28290# Naval Air Warfare Center, China Lake, CA. Weapons Div.
FRACTIONAL BROWNIAN MOTION, WAVELETS, AND INFRARED DETECTOR NOISE Final Report
G. A. Hewer and Wei Kuo Mar. 1993 73 p
(AD-A262956; NAWC-WPNS-TP-8103) Avail: CASI HC A04/MF A01

Fractional Brownian motion (fBm) is the proper model for spatial noise. The noise on infrared arrays has both a temporal and a spatial component. Spatial noise (pixel-to-pixel variation) manifests itself across the array as a nonuniform response by the individual detectors to a uniform illumination. Temporal noise is observed by sampling the time series response from a single pixel. In this report, the pixel responses from an indium antiomide (InSb) staring array are analyzed for their 1/f characteristics. DTIC

71 ACOUSTICS

Includes sound generation, transmission and attenuation.
For noise pollution see *45 Environmental Pollution.*

N93-26606# Florida Univ., Gainesville. Dept. of Chemistry.
ACOUSTIC DETERMINATION OF PHASE EQUILIBRIA Annual Report, Jun. 1991 - May 1992
S. O. Colgate Jun. 1992 31 p
(Contract GRI-5091-260-2299)
(PB93-167120; GRI-92/0487) Avail: CASI HC A03/MF A01

Sonic speeds in a gaseous n-butane and a simulated natural gas mixture were measured in a spherical acoustic resonator and reference state heat capacities and second virial coefficients inferred from the data. A high resolution cylindrical acoustic resonator was developed for study of the fast/slow sound phenomenon in gas mixtures, and experiments with it are underway. NTIS

N93-27058*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
IN-FLIGHT NEAR- AND FAR-FIELD ACOUSTIC DATA MEASURED ON THE PROPFAN TEST ASSESSMENT (PTA) TESTBED AND WITH AN ADJACENT AIRCRAFT
Richard P. Woodward and Irvin J. Loeffler Apr. 1993 161 p
(RTOP 535-03-10)
(NASA-TM-103719; E-6402; NAS 1.15:103719) Avail: CASI HC A08/MF A02

Flight tests to define the far-field tone source at cruise conditions were completed on the full-scale SR-7L advanced turboprop that was installed on the left wing of a Gulfstream 2 aircraft. This program, designated Propfan Test Assessment (PTA), involved aeroacoustic testing of the propeller over a range of test conditions. These measurements defined source levels for input into long-distance propagation models to predict en route noise. In-flight data were taken for seven test cases. Near-field acoustic data were taken on the Gulfstream fuselage and on a microphone boom that was mounted on the Gulfstream wing outboard of the propeller. Far-field acoustic data were taken by an acoustically instrumented Learjet that flew in formation with the Gulfstream. These flight tests were flown from El Paso, Texas, and from the NASA Lewis Research Center. A comprehensive listing of the aeroacoustic results from these flight tests which may be used for future analysis are presented. Author

N93-27127*# Rensselaer Polytechnic Inst., Troy, NY. Dept. of Mathematical Sciences.
RESEARCH SUMMARY Final Report, 15 Nov. 1988 - 14 Nov. 1991
W. L. Siegmann, J. S. Robertson, and M. J. Jacobson 14 May 1993 12 p
(Grant NAG1-929)
(NASA-CR-193082; NAS 1.26:193082) Avail: CASI HC A03/MF A01

The final report for progress during the period from 15 Nov. 1988 to 14 Nov. 1991 is presented. Research on methods for analysis of sound propagation through the atmosphere and on results obtained from application of our methods are summarized. Ten written documents of NASA research are listed, and these include publications, manuscripts accepted, submitted, or in preparation for publication, and reports. Twelve presentations of results, either at scientific conferences or at research or technical organizations, since the start of the grant period are indicated. Names of organizations to which software produced under the grant was distributed are provided, and the current arrangement whereby the software is being distributed to the scientific community is also described. Finally, the names of seven graduate students who worked on NASA research and received Rensselaer degrees during the grant period, along with their current empioyers are given. Author (revised)

N93-27148*# United Technologies Corp., Windsor Locks, CT. Standard Div.
USER'S MANUAL FOR UCAP: UNIFIED COUNTER-ROTATION AERO-ACOUSTICS PROGRAM Final Report
E. M. Culver and C. J. McColgan Apr. 1993 176 p
(Contract NAS3-24222; RTOP 535-03-10)
(NASA-CR-191064; NAS 1.26:191064) Avail: CASI HC A09/MF A02

This is the user's manual for the Unified Counter-rotation Aeroacoustics

Program (UCAP), the counter-rotation derivative of the UAAP (Unified Aero-Acoustic Program). The purpose of this program is to predict steady and unsteady air loading on the blades and the noise produced by a counter-rotation Prop-Fan. The aerodynamic method is based on linear potential theory with corrections for nonlinearity associated with axial flux induction, vortex lift on the blades, and rotor-to-rotor interference. The theory for acoustics and the theory for individual blade loading and wakes are derived in Unified Aeroacoustics Analysis for High Speed Turboprop Aerodynamics and Noise, Volume 1 (NASA CR-4329). This user's manual also includes a brief explanation of the theory used for the modelling of counter-rotation. Author (revised)

N93-27271*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

LOUDNESS AND ANNOYANCE RESPONSE TO SIMULATED OUTDOOR AND INDOOR SONIC BOOMS

Jack D. Leatherwood and Brenda M. Sullivan (Lockheed Engineering and Sciences Co., Hampton, VA.) May 1993 38 p

(RTOP 537-03-21-03)

(NASA-TM-107756; NAS 1.15:107756) Avail: CASI HC A03/MF A01

The sonic boom simulator of the Langley Research Center was used to quantify subjective loudness and annoyance response to simulated indoor and outdoor sonic boom signatures. The indoor signatures were derived from the outdoor signatures by application of house filters that approximated the noise reduction characteristics of a residential structure. Two indoor listening situations were simulated: one with the windows open and the other with the windows closed. Results were used to assess loudness and annoyance as sonic boom criterion measures and to evaluate several metrics as estimators of loudness and annoyance. The findings indicated that loudness and annoyance were equivalent criterion measures for outdoor booms but not for indoor booms. Annoyance scores for indoor booms were significantly higher than indoor loudness scores. Thus, annoyance was recommended as the criterion measure of choice for general use in assessing sonic boom subjective effects. Perceived level was determined to be the best estimator of annoyance for both indoor and outdoor booms, and of loudness for outdoor booms. It was recommended as the metric of choice for predicting sonic boom subjective effects. Author (revised)

N93-27272*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

A LABORATORY STUDY OF SUBJECTIVE RESPONSE TO SONIC BOOMS MEASURED AT WHITE SANDS MISSILE RANGE

Brenda M. Sullivan (Lockheed Engineering and Sciences Co., Hampton, VA.) and Jack D. Leatherwood May 1993 31 p

(RTOP 537-03-21-03)

(NASA-TM-107746; NAS 1.15:107746) Avail: CASI HC A03/MF A01

The Sonic Boom Simulator of the Langley Research Center was used to quantify subjective loudness response to boom signatures consisting of: (1) simulator reproductions of booms recently recorded at White Sands Missile Range; (2) idealized N-waves; and (3) idealized booms having intermediate shocks. The booms with intermediate shocks represented signatures derived from CFD predictions. The recorded booms represented those generated by F15 and T38 aircraft flyovers and represented a variety of waveforms reflecting the effects of propagation through a turbulent atmosphere. These waveforms included the following shape categories: N-waves, peaked, rounded, and U-shaped. Results showed that Perceived Level and Zwicker Loudness Level were good estimators of the loudness of turbulence modified sonic booms. No significant differences were observed between loudness responses for the several shape categories when expressed in terms of Perceived Level. Thus, Perceived Level effectively accounted for waveform differences due to turbulence. Idealized booms with intermediate shocks, however, were rated as being approximately 2.7 dB(PL) less loud than the recorded signatures. This difference was not accounted for by PL. Author (revised)

N93-27662# National Physical Lab., Teddington (England).

A PREDICTION MODEL FOR NOISE FROM LOW-ALTITUDE MILITARY AIRCRAFT

B. F. Berry and J. D. Speakman 13 Mar. 1993 6 p LIMITED REPRODUCIBILITY: More than 20% of this document may be affected by microfiche quality

(AD-A262494; AL-TR-1992-0151) Avail: CASI HC A02/MF A01

For a number of years, the National Physical Laboratory, supported by the Ministry of Defense, has been developing AIRNOISE, a mathematical model for computing aircraft noise contours. As part of the continuous program of development of the model we were asked to extend it to include low-altitude military operations. The objective is to predict the complete time-history of the noise of these vary rapid events, thus providing information on onset rates as well as maximum levels. In order to provide high quality data with which to validate and refine the model, a special noise trial - Exercise Luce Belle - was conducted in which a number of aircraft types flew low, straight and level at various speeds and engine power settings. This paper firstly describes the noise trial and then the prediction models. The comparison of prediction with measurements is discussed. In particular the effects of changes in the assumptions in the model about lateral attenuation are explored. DTIC

N93-27933# Naval Oceanographic and Atmospheric Research Lab., Bay Saint Louis, MS.

A STUDY OF THE HIGHER ORDER LAMB RESONANCES ON ELASTIC SHELLS: THEIR PREDICTION AND INTERPRETATION Final Report, 22 - 24 Apr. 1992

M. F. Werby, M. K. Broadhead, and Firooz A. Sadjadi Apr. 1992 11 p

(AD-A262237; NOARL-PR-92-081-221) Avail: CASI HC A03/MF A01

We study all the resonances generated on elastic shells for a ka from 0 to 500 for steel and aluminum for a thickness of 5%. We observe the lowest order symmetric and antisymmetric model or Lamb resonances, waterborne and pseudo-Stoneley resonances and the higher order Lamb modes A and S, where i = 1, 2, 3 ... . We plot some of the phase velocities of some of the relevant resonances out to a ka of 500 and indicate simple expressions that predict the onset of each of the resonances. We demonstrate by use of partial wave analysis that the new expressions that predict the onset (critical frequencies) of the higher order Lamb modes are reliable. Further, interesting phenomena occur at the inception of some of the resonances and we discuss some of those cases. DTIC

N93-28153# Sandia National Labs., Albuquerque, NM.

UTILIZATION OF POLYMER VISCOELASTIC PROPERTIES TO ENHANCE ACOUSTIC WAVE SENSOR PERFORMANCE

G. C. Frye and S. J. Martin 1992 9 p Presented at the Chemical Sensor Symposium, Honolulu, HI, 16-21 May 1993

(Contract DE-AC04-76DP-00789)

(DE93-008345; SAND-92-2450C; CONF-9305124-2) Avail: CASI HC A02/MF A01

Polymer films are commonly used as the sorptive layer for preparing chemical sensors using surface acoustic wave (SAW) devices. Absorption of chemical species into these polymer coatings results in plasticization (i.e., softening) of the polymer. We have demonstrated that SAW devices are sensitive to the resulting changes in viscoelastic properties, especially due to the onset of a film resonance. This film resonance occurs when the inertial phase lag across the film approaches (pi)/2. Based on understanding these acoustic wave/polymer film interactions and the resulting changes in wave velocity and attenuation, device sensitivity can be significantly increased and the ability to utilize both responses to discriminate between isolated chemical species with a single SAW device can be improved. DOE

N93-28179# Naval Postgraduate School, Monterey, CA.

A THREE-DIMENSIONAL COUPLED NORMAL MODE MODEL FOR SOUND PROPAGATION IN SHALLOW WATER WITH IRREGULAR BOTTOM BATHYMETRY M.S. Thesis

George A. Sagos Dec. 1992 71 p

(AD-A262101) Avail: CASI HC A04/MF A01

A three-dimensional (3D) coupled normal mode model for studying sound propagation in a complex coastal environment is developed. This development corresponds to a significant upgrade of earlier version of the model in which a flat, rigid bottom was used. By imposing the general boundary conditions for an irregular, non-rigid bottom, the coupling coefficient integrals in the system of differential equations governing the mode amplitude are reformulated. The model upgrade entails a numerical implementation of the revised formulae. With the improved physics, this latest version is capable of modeling the 3D acoustic wave-field in shallow water where sound speed, water depth, and sediment properties can vary with horizontal

location. To demonstrate this enhanced capability, the model is used here to simulate the interactions of the normal modes as they propagate up a sloping bottom. DTIC

N93-28191# Naval Postgraduate School, Monterey, CA.
MICROCOMPUTER SIMULATION OF A FOURIER APPROACH TO ULTRASONIC WAVE PROPAGATION M.S. Thesis
William H. Reid Dec. 1992 104 p
(AD-A262090) Avail: CASI HC A06/MF A02

This thesis uses linear systems approach and the Fourier transform as the basis for a microcomputer program to model pulsed ultrasonic wave propagation. The program computes the acoustic potential in a plane at a given distance from the source. The mathematical development establishes the importance of the total impulse response as the Green's function, meeting the boundary conditions and solving the wave equation. Four excitation functions are presented. The square and circular piston excitations are used to verify the program. Excitation functions also modeled are the circularly truncated Gaussian distribution and the circularly truncated Bessel profile. All programs were written using the MATLAB software package. This work provides a computationally efficient means to analyze pulsed ultrasonic wave propagation as a spatially filtered source. DTIC

72 ATOMIC AND MOLECULAR PHYSICS

Includes atomic structure, electron properties, and molecular spectra.

N93-26610# California Univ., Berkeley. Lawrence Berkeley Lab.
HADRONIC PRODUCTION OF J/PSI AT LARGE CHI(SUB F) IN 800 GeV p+Cu AND p+Be COLLISIONS Ph.D. Thesis
M. S. Kowitt Dec. 1992 110 p
(Contract DE-AC03-76SF-00098)
(DE93-007706; LBL-33331) Avail: CASI HC A06/MF A02

The differential cross-section d(sigma)/d(chi(sub F)) for J/(psi) production in 800 GeV proton-nucleus collisions has been measured in the kinematic range 0.30 less than or equal to chi(sub f) less than or equal to 0.95 and chi(sub f) less than p(perpendicular) less than 5 GeV through the decay mode J/(psi) (yields) (mu)(sup +)(mu)(sup (minus)). The nuclear dependence of J/(psi) production over this range was measured using copper and beryllium targets. The differential cross sections are in good agreement with the predictions of the symbolical parton duality model. The data show no evidence for an intrinsic charm component in the proton. The ratio of the differential cross sections for copper and beryllium shows a suppression of J/(psi) production in copper which increases with increasing chi(sub F). DOE

N93-26614# California Univ., Berkeley. Lawrence Berkeley Lab.
TOWARDS ROTATIONALLY STATE-RESOLVED DIFFERENTIAL CROSS SECTIONS FOR THE HYDROGEN EXCHANGE REACTION Ph.D. Thesis
M. J. J. Vrakking Nov. 1992 166 p
(Contract DE-AC03-76SF-00098)
(DE93-007735; LBL-33219) Avail: CASI HC A08/MF A02

The hydrogen exchange reaction H + H2 (yields) H2 + H (and its isotopic variants) plays a pivotal role in chemical reaction dynamics. It is the only chemical reaction for which fully converged quantum scattering calculations have been carried out using a potential energy surface which is considered to be chemically accurate. To improve our ability to test the theory, a 'perfect experiment,' measuring differential cross sections with complete specification of the reactant and product states, is called for. In this thesis, the design of an experiment is described that aims at achieving this goal for the D + H2 reaction. A crossed molecular beam arrangement is used, in which a photolytic D atom beam is crossed by a pulsed beam of H2 molecules. DH molecules formed in the D + H2 reaction are state-specifically ionized using Doppler-free (2+1) Resonance-Enhanced Multi-Photon Ionization (REMPI) and detected using a Position-sensitive microchannel plate detector. This detection technique has an unprecedented single shot detection sensitivity of 6.8(10)(exp 3) molecules/cc. This thesis does not contain experimental results for the D + H2 reaction yet, but progress that has been made towards achieving this goal is reported. In addition, results are reported for a study of the Rydberg spectroscopy of the water molecule. DOE

N93-26625# Argonne National Lab., IL. Advanced Photon Source Accelerator Systems Div.
FURTHER TIME-RESOLVED ELECTRON-BEAM CHARACTERIZATIONS WITH OPTICAL TRANSITION RADIATION
A. H. Lumpkin and M. D. Wilke (Los Alamos National Lab., NM.) 1992 10 p Presented at the 1992 Accelerator Instrumentation Workshop, Berkeley, CA, 27-30 Oct. 1992
(Contracts W-31-109-eng-38; W-7405-eng-36)
(DE93-007891; ANL/ASD/CP-77463; CONF-9210246-16) Avail: CASI HC A02/MF A01

Time-resolved characterizations of electron beams using optical transition radiation (OTR) as a prompt conversion mechanism have recently been extended on the Los Alamos Free-electron Laser (FEL) facility 40-MeV linac. Two key timescales for RF-linac driven FEL's are the micropulse (10 ps) and the macropulse (5 (mu)s to 1 ms). In the past we have used gated, intensified cameras to select a single or few micropulses (25 to 400 ns gate width) out of the pulse train to evaluate submacropulse effects. Recently, we have obtained some of the first measurements of micropulse bunch length (7 to 10 ps) and submacropulse spatial position and profile using OTR and a Hamamatsu streak camera. Additionally, micropulse elongation effects and head-to-tail transverse kick effects are reported as a function of charge. DOE

N93-26626# Argonne National Lab., IL.
OVERVIEW OF CHARGED-PARTICLE BEAM DIAGNOSTICS FOR THE ADVANCED PHOTON SOURCE (APS)
A. H. Lumpkin, G. Decker, E. Kahana, D. Patterson, W. Sellyey, A. Votaw, X. Wang, and Y. Chung 1992 8 p Presented at the 1992 Accelerator Instrumentation Workshop, Berkeley, CA, 27-30 Oct. 1992
(Contract W-31-109-eng-38)
(DE93-007898; ANL/ASD/CP-77466; CONF-9210246-14) Avail: CASI HC A02/MF A01

Plans, prototypes, and initial test results for the charged-particle beam (e-,e+) diagnostic systems on the injector rings, their transport lines, and the storage ring for the Advanced Photon Source (APS) are presented. The APS will be a synchrotron radiation user facility with one of the world's brightest x-ray sources in the 10-keV to 100-keV regime. Its 200-MeV electron linac, 450-MeV positron linac, positron accumulator ring, 7-GeV booster synchrotron, 7-GeV storage ring, and undulator test lines will also demand the development and demonstration of key particle-beam characterization techniques over a wide range of parameter space. Some of these parameter values overlap or approach those projected for fourth generation light sources (linac-driven FEL's and high brightness storage rings) as described at a recent workshop. Initial results from the diagnostics prototypes on the linac test stand operating at 45-MeV include current monitor data, beam loss monitor data, and video digitization using VME architecture. DOE

N93-27048# Texas Univ., Austin. Dept. of Physics.
STUDIES IN MEDIUM ENERGY PHYSICS
G. W. Hoffmann, J. McDonough, M. J. Purcell, R. L. Ray, D. M. Read, and S. D. Worm Dec. 1992 12 p
(Contract DE-FG05-88ER-40444)
(DE93-007305; DOE/ER-40444/5) Avail: CASI HC A03/MF A01

Progress is briefly reported in the following areas: p + A precision elastic forward-angle cross sections for 500- to 800-MeV p on Ca-40; precision measurement of D(sub NN) for C-14(rvec p), (rvec p) at 500 MeV; design of a polarized nuclear target; search for very rare K(sub L) decays; search for the H dibaryon; experimental search for quark -- gluon plasma; and theoretical work on proton -- nucleus scattering. DOE

N93-27425# National Inst. of Standards and Technology, Gaithersburg, MD. Ionizing Radiation Div.
DOSE IN WATER FROM EXTERNAL IRRADIATION BY ELECTRONS: RADIATION PROTECTION DATA
S. M. Seltzer Feb. 1993 20 p Sponsored by DOE
(PB93-173425; NISTIR-5136) Avail: CASI HC A03/MF A01

Results from electron Monte Carlo calculations are given for the absorbed dose at depths of 7, 40, 300 and 1000 mg/sq cm in a slab water phantom irradiated by electrons incident with kinetic energies from 50 keV to 10 MeV and at angles (with respect to the normal to the surface) of 0, 15,

30, 45, 60, 75 and 89 deg. Electron number and energy reflection coefficients are given also for these cases. NTIS

N93-27486# Oak Ridge National Lab., TN.
LOW-SPIN IDENTICAL BANDS IN NEIGHBORING ODD-A AND EVEN-EVEN NUCLEI
C. Baktash, D. F. Winchell, J. D. Garrett, and A. Smith 1992 12 p Presented at the 1992 International Symposium on Rapidly Rotating Nuclei, Tokyo, Japan, 26-30 Oct. 1992
(Contract DE-AC05-84OR-21400)
(DE93-008569; CONF-9210249-8) Avail: CASI HC A03/MF A01

A comprehensive study of odd-A rotational bands in normally deformed rare-earth nuclei indicates that a large number of seniority-one configurations (21 percent for odd-Z nuclei) at low spin have moments of inertia nearly identical to that of the seniority-zero configuration of the neighboring even-even nucleus with one less nucleon. It is difficult to reconcile these results with conventional models of nuclear pair correlation, which predict variations of about 15 percent in the moments of inertia of configurations differing by one unit in seniority. DOE

N93-27508# Nationaal Inst. voor Kernfysica en Hoge Energiefysica, Amsterdam (Netherlands). Lab. de Physique Corpusculaire.
SEMIWEAK PRODUCTION OF A TOP QUARK ACCOMPANIED BY A BOTTOM QUARK AND 2 JETS AT HADRON COLLIDERS
G. Bordes (College de France, Paris.) and B. vanEijk (European Organization for Nuclear Research, Geneva, Switzerland.) 16 Feb. 1992 15 p Sponsored by Netherlands Organization for Scientific Research
(NIKHEF-H/91-27; ETN-93-93295) Avail: CASI HC A03/MF A01

A computation for the process of semiweak production of a top and a bottom quark accompanied by two jets is presented. The calculation is performed using the helicity formalism generalized to include massive fermions. The obtained matrix element squared allows for an accurate simulation of single top quark production in hadronic interactions with realistic transverse momentum and angular distributions for the jets in the event. Differential cross sections are compared with previously obtained distributions from O(alpha(sub s), alpha squared) calculations. ESA

N93-27520# Texas A&M Univ., College Station. Cyclotron Inst.
EXCITATION OF ATOMS AND MOLECULES IN COLLISIONS WITH HIGHLY CHARGED IONS
R. L. Watson 1 Jan. 1993 74 p
(Contract DE-FG05-84ER-13262)
(DE93-007306; DOE/ER-13262/9) Avail: CASI HC A04/MF A01

A study of the double ionization of He by high-energy N(sup 7+) ions was extended up in energy to 40 MeV/amu. Coincidence time-of-flight studies of multicharged N2, O2, and CO molecular ions produced in collisions with 97-MeV Ar(sup 14+) ions were completed. Analysis of the total kinetic energy distributions and comparison with the available data for CO(sup 2+) and CO(sup 3+) from synchrotron radiation experiments led to the conclusion that ionization by Ar-ion impact populates states having considerably higher excitation energies than those accessed by photoionization. The dissociation fractions for CO(sup 1+) and CO(sup 2+) molecular ions, and the branching ratios for the most prominent charge division channels of CO(sup 2+) through CO(sup 7+) were determined from time-of-flight singles and coincidence data. An experiment designed to investigate the orientation dependence of dissociative multielectron ionization of molecules by heavy ion impact was completed. Measurements of the cross sections for K-shell ionization of intermediate-Z elements by 30-MeV/amu H, N, Ne, and Ar ions were completed. The cross sections were determined for solid targets of Z = 13, 22, 26, 29, 32, 40, 42, 46, and 50 by recording the spectra of K x rays with a Si(Li) spectrometer. DOE

N93-27521# Los Alamos National Lab., NM.
MEASURING PION BETA DECAY WITH HIGH-ENERGY PION BEAMS
W. K. McFarlane (Superconducting Super Collider Lab., Dallas, TX.) and C. M. Hoffman 1993 14 p Presented at the Workshop on New Vistas in Physics with High-Energy Pion Beams, Santa Fe, NM, 14 Oct. 1992
(Contract W-7405-eng-36)
(DE93-007347; LA-UR-93-140; CONF-9210292-2) Avail: CASI HC A03/MF A01

Improved measurements of the pion beta decay rate are possible with an intense high-energy pion beam. The rate for the decay pi(+) yields pi(0) e(+) v(epsilon) is predicted by the Standard Model (SM) to be R(pi(+) yields pi(0) e(+) v(epsilon)) = 0.3999 plus/minus 0.0005 s(sup -1). The best experimental number, obtained using in-flight decays, is R(pi(+) yields pi(0) e(+) v(epsilon)) = 0.394 plus/minus 0.015 s(sup -1). A precise measurement would test the SM by testing the unitarity of the Cabibbo-Kobayashi-Maskawa matrix for which one analysis of the nuclear beta decay data has shown a 0.4% discrepancy. Several nuclear correction factors, needed for nuclear decay, are not present for pion beta decay, so that an experiment at the 0.2% level would be a significant one. Detailed study of possible designs will be needed, as well as extensive testing of components. The reduction of systematic errors to the 0.1% level can only be done over a period of years with a highly stable apparatus and beam. At a minimum, three years of occupancy of a beam line, with 800 hours per year, would be required. DOE

N93-27529# National Inst. of Standards and Technology, Gaithersburg, MD.
BIBLIOGRAPHY ON ATOMIC LINE SHAPES AND SHIFTS Special Publication, Jul. 1978 - Mar. 1992
J. R. Fuhr and A. Lesage (Observatoire de Paris-Meudon, France.) Jan. 1993 300 p See also PB-289815 LIMITED REPRODUCIBILITY: More than 20% of this document may be affected by microfiche quality
(PB93-173433; NIST/SP-366-Suppl-4) Avail: Issuing Activity (National Technical Information Service (NTIS))

This is the fourth supplement to the original NBS Special Publication 366, Bibliography on Atomic Line Shapes and Shifts (1889 through March 1972). It contains 1964 references and covers the literature from July 1978 to March 1992. As in the authors' previous publications, the bibliography consists of five major parts: (1) Part 1 is a section containing papers of general interest, many without numerical data. These papers are catalogued according to the broadening mechanisms. (2) In Part 2, all papers containing numerical data are ordered according to element, ionization stage, and broadening mechanism. (3) While in the two preceding parts of the bibliography the references are listed for brevity by identification numbers only, in Part 3 all references are listed completely by journal, authors, and title. In addition, the papers are arranged by year of publication and alphabetically by the first author's name within the year. (4) Part 4 contains a listing of all authors and their papers, as identified by the reference numbers from Part 3. (5) Part 5 provides corrections and/or additions to the third supplement of the original bibliography. NTIS

N93-27618# Los Alamos National Lab., NM.
PRODUCTION OF ULTRA COLD PROTONS AND NEGATIVE HYDROGEN IONS
R. A. Kenefick Jul. 1992 32 p Prepared in cooperation with Texas A and M Univ., College Station, TX
(Contract W-7405-eng-36)
(DE93-008328; LA-SUB-93-42) Avail: CASI HC A03/MF A01

Resistive cooling of He(+) ions has been studied in a 4 K Penning trap optimized for omega(+) cooling. A Nb/Ti superconducting inductor gives a Q of 1800 resulting in energy cooling time constants as low as 1.8 seconds and the cooling has been followed from 60,000 K to 300 K. In a separate study in a room-temperature trap, the possible conversion of H(+) to H(-) at a cesiated trap electrode and subsequent capture of the H(-) by fast reversal of the trap electrode polarity was not yet proved to be a workable mechanism. Features of the apparatus and technique are briefly described and the details are continued in three publications attached as appendices. DOE

N93-27638# Rome Univ. (Italy). Dipt. di Fisica.
B(SUB c) DECAYS
M. Lusignoli (Istituto Nazionale di Fisica Nucleare, Rome, Italy.) and M. Masetti 20 Dec. 1990 20 p Submitted for publication
(SSCL-Preprint-774; ETN-93-93662) Avail: CASI HC A03/MF A01

Theoretical predictions in decay properties of the simplest particle containing more than one heavy quark, the pseudoscalar meson, are presented. Some channels that should present a distinctive signature are discussed. The investigation is carried out by applying a quantum chromodynamics corrective effective hamiltonian and operator matrix elements evaluated in the vacuum insertion approximation and in the large N(sub c) limit. The results of inclusive decays predict the contribution to

the total rate of different decay mechanisms to be 37 percent from C-spectator decays, 45 percent from (bar-b)-spectator, and 18 percent from c(bar-b) annihilation. ESA

N93-27648# Rice Univ., Houston, TX.
ENERGY AND CHEMICAL CHANGE Final Report, 1 Nov. 1988 - 31 Oct. 1992
James L. Kinsey and Raphael D. Levine Jan. 1993 71 p
(Grant AF-AFOSR-0158-89)
(AD-A262359; AFOSR-93-0193TR) Avail: CASI HC A04/MF A01

The overall object of this project was a better theoretical understanding of the dynamics of energy rich molecules, in both bound and unbound states. Particular attention was to be given to the understanding and elucidation of selectivity in the role of initial energy acquisition and its subsequent disposal. Some effort was directed at the understanding of such selectivity not only for isolated molecules but also for molecule-surface collisions. Two novel methodologies were developed and brought to fruition during these studies. One is the use of algebraic Hamiltonians for the description of high overtones (and hence highly anharmonic) energy rich states and the determination of the potential energy from observed spectra in this way. Very extensive work has demonstrated the realistic feasibility of this approach for triatomic molecules (both linear and bent) and for linear tetratomic molecules. A complete summary of this approach has just been written up for publication as a book which includes table of parameters of algebraic Hamiltonians for a variety of molecules. DTIC

N93-27658# Northwestern Univ., Evanston, IL. Dept. of Chemistry.
FAST INTERFACIAL ELECTRON TRANSFER: EVIDENCE FOR INVERTED REGION KINETIC BEHAVIOR
Hong Lu, Janice N. Preiskorn, and Joseph T. Hupp 19 Feb. 1993 11 p
(Contract N00014-91-J-1035)
(AD-A262434; TR-13) Avail: CASI HC A03/MF A01

Interfacial electron transfer (ET) in a prototypical semiconductor-liquid junction system (aq. Fe(CN)6 4-/3- with TiO2) can be initiated by directly pumping a molecule to surface charge transfer transition (lambda-max = 430nm). The return electron transfer(ET) kinetics, which can be monitored by visible-region transient-absorbance spectroscopy, reveal a well-defined fast component (t = 270ns) and a less well defined slow component. Detailed studies in the shorter time regime show that: (1) the interfacial ET rate is independent of laser pump power and, therefore, truly first order, (2) the kinetics are activationless, and (3) the kinetics are inverted, i.e. the ET rate decreases when the free energy driving force is increased by increasing the formal potential of the iron(III)-based electron acceptor. The results are broadly consistent with the predictions of contemporary, multimode quantum rate theories; they are also consistent with the findings of a prior study (by time-dependent scattering) of the Franck-Condon effects accompanying the reaction. DTIC

N93-27677# Minnesota Univ., Minneapolis. Dept. of Chemical Engineering and Materials Science.
SIMULATIONS OF SOLVENT EFFECTS ON CONFINED ELECTROLYTES
Lianrui Zhang, H. T. Davis, and Henry S. White 20 Mar. 1993 22 p
(Contract N00014-91-J-1927)
(AD-A262294; TR-7) Avail: CASI HC A03/MF A01

Monte Carlo simulations are reported for the solvent primitive model (SPM) of the electrical double layer at electrically charged and neutral surfaces. Both solvent and ions are modeled as hard spheres with interactions governed by hard sphere and Coulomb interactions. Density profiles of solvent and ions and electrostatic potential profiles are presented for 1:1 electrolyte concentrations of 1 and 2M at 300K. Comparison of results at charged and neutral walls indicates that the density distribution of a dense solvent near a wall induces significant layering of ions and decrease of potentials in the double layer. This layering effect cannot be captured in simulations of the conventional primitive model (PM) of the double layer. The solvent induced steric ordering of electrolyte ions at a neutral wall can create a space charge layer. DTIC

N93-27685# Bowling Green State Univ., OH. Center for Photochemical Sciences.
HOT BANDS IN OVERTONE ABSORPTION TRANSITIONS: HIGH TEMPERATURE SPECTRA Technical Report
Salah Hassoon and Deanne Snavely 17 Mar. 1993 26 p
(Contract N00014-88-K-4130)
(AD-A262213; TR-11) Avail: CASI HC A03/MF A01

The laser photoacoustic spectra of the 4v sub N-H and 4v sub C-H overtones of pyrrole, the 5v sub c-H of methyl isocyanide and acetonitrile, the 5v sub c-H and 6v sub C-H of isobutane, and the 6v sub c-H of cyclohexane were measured at temperatures up to 140 C (T sub 140) and compared to the room temperature (T sub rt) spectra. Hot bands were identified by their temperature dependence in pyrrole, methyl isocyanide and isobutane. From the change in the relative intensities of the hot band to the main band going from T sub rt to T sub 140, the wavenumbers of the thermally populated states were 405 +/- 80, 410 +/- 80 and 208 +/- 40 /cm for pyrrole, isobutane and methyl isocyanide, respectively. These values compare well to the bending motion frequencies in these molecules. Large red shifts of the hot bands from the main peak were observed, as expected for high overtone transitions due to large anharmonicities. The anharmonic constants determined from these shifts are -25 /cm for the N-H in pyrrole and -20 /cm for the C-H in methyl isocyanide and isobutane. In the case of the N-H absorption the hot band was completely separated from the transition. In the C-H overtone spectra these hot band absorptions were not separated and result in an apparent increased width of the overtone transition. DTIC

N93-27696# Colorado Univ., Boulder. Dept. of Chemistry and Biochemistry.
STRUCTURE AND PROPERTIES OF NOVEL COMPOUNDS OF SILICON, GERMANIUM AND TIN Final Report, 1 Oct. 1990 - 30 Sep. 1992
Josef Michl 30 Nov. 1992 7 p
(Grant AF-AFOSR-0032-91)
(AD-A262445; AFOSR-93-0176TR) Avail: CASI HC A02/MF A01

Our work on the organic chemistry of silicon, germanium, and tin containing compounds concentrated on the investigation of novel structures and bonding situations, particularly compounds of multiply bonded and divalent atoms of these elements. In the recent years, our interest gradually gravitated towards an interrogation of the electronic structure and bonding in saturated compounds of these elements, most of all, silicon. We believe that an understanding of this subject will have quite general consequences for the understanding of the nature of delocalized chemical bonding in saturated compounds of all main-group elements. After all, the fact that bonding in saturated compounds is not strictly a matter of entirely localized single bonds is responsible for many theoretically and practically important properties of these compounds: sigma delocalization plays an essential role in phenomena as diverse as charge transfer through 'inert' spacers, propagation of substituent effects, propagation of spin density in saturated radicals, nuclear-nuclear coupling in NMR of saturated molecules, their optical activity, far UV absorption, ionization, etc. DTIC

N93-27699# Rome Univ. (Italy). Dipt. di Fisica.
HEAVY QUARK MASSES
Massimo Testa 17 Dec. 1990 4 p Submitted for publication
Sponsored in part by NASA
(Grant NSF PHY-89-04035)
(SSCL-Preprint-772; ETN-93-93661) Avail: CASI HC A01/MF A01

In the large quark mass limit, an argument which identifies the mass of the heavy-light pseudoscalar or scalar bound state with the renormalized mass of the heavy quark is given. The following equation is discussed: m(sub Q) = m(sub B), where m(sub Q) and m(sub B) are respectively the mass of the heavy quark and the mass of the pseudoscalar bound state. ESA

N93-27701# Rome Univ. (Italy). Dept. of Physics.
COLLABORATIONS AMONG NUCLEAR EMULSION GROUPS IN EUROPE DURING THE 1950'S
M. Grilli and F. Sebastiani 27 Feb. 1991 29 p Presented at the Seminar on the History of Science, Rome Univ., Italy
(Nota-Interna-973; ETN-93-93705) Avail: CASI HC A03/MF A01

Three cases of collaborative research between European groups working with nuclear emulsions are discussed. These collaborations provide a meaningful example of a new style of research in the field of elementary particle physics. The following topics are reported: the origin and the organization of these European collaborations; information and details on

the expeditions; information and comments by some of the participants; and the state of the elementary particle knowledge before and after the collaborations. ESA

N93-27829# University of North Texas, Denton. Dept. of Physics.
ACCELERATOR MASS SPECTROMETRY FACILITY (AMS) Final Progress Report
Floyd D. McDaniel 29 Dec. 1992 1 p
(Contract N00014-91-J-1785)
(AD-A262458) Avail: CASI HC A01/MF A01

An accelerator mass spectrometry (AMS) facility was developed at the Ion Beam Modification and Analysis Laboratory (IBMAL) at the University of North Texas (UNT) in conjunction with the 3 MV Tandem Accelerator. The computer controlled AMS instrument allows automatic mass scans of stable isotopes in solid materials using a new ultra-clean, low sample contamination ion source. The AMS instrument allows molecular interference-free mass scans to be obtained with a higher sensitivity than Secondary Ion Mass Spectrometry (SIMS) for many elements. The new low sample contamination, microbeam, raster-scanning, depth-profiling ion source, that was recently completed, should allow sensitivities of ppt (1 part in 10(exp 12) or 10(exp 10) atoms/cu cm) for almost any element in the periodic table as well as secondary electron imaging of a sample. Raster scanning and depth profiling capabilities should be available by the first quarter of 1993. Microbeam capabilities should be available by the second quarter of 1992. DTIC

N93-27954# IBM Research Lab., San Jose, CA.
MOLECULAR DYNAMICS MODELING OF ELECTRIC DOUBLE LAYER
James N. Glosli and Michael R. Philpott 14 Apr. 1993 19 p
(Contract N00014-92-C-0173)
(AD-A263068; TR-04) Avail: CASI HC A03/MF A01

Constant temperature molecular dynamics calculations of a simple model of a charged metal electrode immersed in electrolyte show the following features known to exist experimentally: incipience of a compact layer, formation of a diffuse layer, presence of highly oriented water layer next to the metal, penetration of nominally diffuse layer species into inner Helmholtz region, and ion pair formation between a contact adsorbed ion and a diffuse layer ion. All these effects emerge from calculations with the same basic model when either the electrolyte composition or the electrode charge are changed. The systems studied had the general composition nI(-) + mLi(+) + (158 - n - m)H2O where (n,m) = (0,0), (1,0), (0,1), (1,1), and (2,1). The simulation cell had one metal electrode and one constraining dielectric surface. The surface charge on the metal was q(sub M) = 0, +/- e the latter corresponding to electric fields of about +/- 5 x 10(exp 7) V/cm. The net charge in aqueous phase was fixed at q(sub Aq) = q(sub M). The st2 water model and parametrs for lithium iodide were used in the calculations. The temperature was 290 K. The fast multipole method for long range coulomb interactions was used to calculate all electrical forces. This is the first application of molecular dynamics combined with the fast multipole method to study properties of electric double layers at a metal surface. DTIC

N93-28008# Sandia National Labs., Albuquerque, NM.
NON-TRADITIONAL ION BEAM ANALYSES
B. L. Doyle, J. A. Knapp, J. C. Banks, J. C. Barbour, and D. S. Walsh 1993 50 p Presented at the 2nd Harima International Symposium on Material Processing By Non-Traditional Techniques, Hemiji, Japan, 9-10 Feb. 1993
(Contract DE-AC04-76DP-00789)
(DE93-007590; SAND-93-0193C; CONF-930259-1) Avail: CASI HC A03/MF A01

Rutherford backscattering spectrometry (RBS), elastic recoil detection (ERD), proton induced x-ray emission (PIXE), and nuclear reaction analysis (NRA) are among the most commonly used, or traditional, ion beam analysis (IBA) techniques. In this review, several adaptations of these IBA techniques are described where either the approach used in the analysis or the application area is clearly non-traditional or unusual. These analyses and/or applications are summarized in this paper. DOE

N93-28097# Rome Univ. (Italy). Dept. of Physics.
SUMMARY TALK
L. Maiani (Istituto Nazionale di Fisica Nucleare, Rome, Italy.) 10 Jan. 1990 12 p Presented at the Eurphysics Conference on High-Energy Physics, Madrid, Spain, 6-13 Sep. 1989 Submitted for publication
(SSCL-Preprint-724; ETN-93-93625) Avail: CASI HC A03/MF A01

Recent experimental results and progress made in the field of particle physics are summarized. The attention is focused on flavor physics, CP-violation, Z and W physics. The B-meson decays and the inclusive decay rates of a pseudoscalar meson are discussed. The results obtained for the branching ratios of exclusive semileptonic B-decays are given. Some problems which found the discrepancy between experimental and theoretical value concerning the inclusive semileptonic branching ratio and the CP-violation are summarized. The mass problem concerning the Higgs boson and the top quark described by the Standard Model are considered. Much is expected from the new generation devices in order to clarify several aspects of particle physics which are unsolved up to now. ESA

N93-28099# Rome Univ. (Italy). Dept. of Physics.
NUMBER OF SADDLE POINTS OF THE ENERGY SURFACE IN SK SPIN-GLASS
D. Vertechi and M. A. Virasoro 20 Feb. 1990 11 p Submitted for publication
(SSCL-Preprint-726; ETN-93-93627) Avail: CASI HC A03/MF A01

The average number of energy saddle points in the infinite range using spin glass model, in the annealed approximation, is analytically estimated. The computation is an extension of the work of Bray and Moore about the average number of metastable states. The results of the numerical simulations in energy barriers in the SK model are summarized. ESA

N93-28100# Rome Univ. (Italy). Dept. of Physics.
SQUEEZING PHENOMENA IN INTERACTING ELECTRON-PHONON SYSTEMS
Denis Feinberg (Grenoble-1 Univ., France.), Sergio Ciuchi, and Ferdinando dePasquale (Aquila Univ., Italy.) 22 Feb. 1990 80 p Submitted for publication
(SSCL-Preprint-727; ETN-93-93628) Avail: CASI HC A05/MF A01

The molecular-crystal model of electrons coupled to Einstein phonons is studied as a function of the two parameters: the coupling constant lambda and the ratio of the electron-phonon coupling energy to the phonon energy, denoted by alpha. Both the one electron and the many electron models, starting from the adiabatic limit and from the anti-adiabatic, are considered. A short summary of coherent and squeezed states properties is presented. The small polaron concept in the Holstein molecular crystal model and the modification introduced by the use of squeezed lattice states are reviewed. The different regimes encountered as one varies the two basic parameters of the problem is discussed and the polaron band problem is treated. The results of the toy polaron problem and the generalization of these results to the lattice polaron case are presented. Perspectives for future work and the relevance of superconductivity mechanisms are discussed. ESA

N93-28114# California Univ., Santa Barbara. Dept. of Chemistry.
TETRAHEDRAL-ATOM 3-RING GROUPINGS IN ONE-DIMENSIONAL INORGANIC CHAINS: Be2AsO4OH-4H2O AND Na2ZnPO4OH-7H2O Technical Report, 1 Jun. 1992 - 31 May 1993
William T. Harrison, Tina M. Nenoff, Thurman E. Gier, and Galen D. Stucky 15 Feb. 1993 33 p
(Contract N00014-90-J-1159)
(AD-A262670) Avail: CASI HC A03/MF A01

The 'zeolitic' MXO4-based framework (M = Zn, Be, X = P, As) structure field has recently been shown to be a very extensive one by ourselves and others. A seemingly general feature of these new zeolitic (Zn/Be,P/As,O)-framework phases is a preference for a 1:1 M to X ratio and strict alternation of MO4 and XO4 tetrahedra, akin to a 'Lowenstein's rule' Al-O-Al avoidance and consequent Si/Al Tetrahedral alternation for 1:1 Si to Al ratio aluminosilicate phases. This feature would appear to militate against Zn/Be,P/As,O molecular sieves with odd- as opposed to even-membered ring systems, and also against phases whose M:X ratio is non-unity. We describe the preparations, structures and properties of two new phases; a zincophosphate, Na2ZnPO4OH(dot)7H2O (NaZnPO), and a berylloarsenate, Be2AsO4OH(dot)4H2O (BeAsO), which are non-zeolitic, but contain 1-dimensional chains, whose building blocks include tetrahedral 3-rings. DTIC

N93-28142# Rome Univ. (Italy). Dept. of Physics.
PHYSICAL PARAMETERS OF THE INTERMEDIATE VECTOR BOSON IN THE STANDARD ELECTROWEAK THEORY AND THE t-QUARK MASS
Arianna Borrelli (Istituto Nazionale di Fisica Nucleare, Rome, Italy.), Luciano Maiani (Istituto Nazionale di Fisica Nucleare, Rome, Italy.), and Renata Sisto (Istituto Nazionale di Fisica Nucleare, Rome, Italy.) 9 Aug. 1990 19 p Submitted for publication Sponsored in part by Ministry of Public Education, Italy
(SSCL-Preprint-757; ETN-93-93649) Avail: CASI HC A03/MF A01

Recent Large Electron-Positron (LEP) storage ring and collider data in intermediate vector bosons are compared to the prediction of the Standard Electroweak Theory, to one-loop precision. Observables measured in a single LEP experiment, namely M(sub z), the total width, gamma(sub z), and the partial widths into charged leptons or hadrons, gamma(sub 1) and gamma(sub h), are compared to the M(sub w)/M(sub z) ratio. Assuming the Higgs boson mass in the range (40 to 800) GeV, an agreement is obtained, for the t-quark mass in the range (80 to 210) GeV. LEP experiments improved the understanding of the systematic errors. At the same time, proton-anti-proton collider experiments reached their ultimate limit of prevision in the measurement of W mass, to be improved only the next generation of experiments at LEP 200. ESA

N93-28158# Lawrence Livermore National Lab., CA.
NUCLEAR ISOMERS AS ULTRA-HIGH-ENERGY-DENSITY MATERIALS
C. H. Poppe, M. S. Weiss, and J. D. Anderson 24 Sep. 1992 5 p Presented at the Airforce Meeting on High Energy Density Materials, Lancaster, CA, 23-26 Jun. 1992 Revised
(Contract W-7405-eng-48)
(DE93-009076; UCRL-JC-109928-Rev-1; CONF-9206349-1-Rev-1) Avail: CASI HC A01/MF A01

A major energy advance could result if the enormous potential of nuclear energy storage could be tapped without the penalty of radioactive by-products. Recent research has uncovered a new method for nuclear energy storage with high energy density and no residual radioactivity. Nuclear isomers are metastable states of atomic nuclei which release their energy in a prompt burst of electromagnetic radiation; in many cases the product remaining after decay of isomer is stable and no activity is produced by the electromagnetic decay. Two kinds of nuclear isomers are known: spin isomers and shape isomers. The former lacks a release mechanism. Theory has predicted the existence of shape isomers in the mass range around mercury and gold where decay by fission is prohibited. Experiments on the existence of fissionless shape isomers have resulted in evidence for 27 different shape isomers in isotopes of mercury, lead, and thallium. Three potential candidates for release mechanisms have been identified to date: neutron catalysis (Hf- 178), laser-electron-nuclear coupling (Th-229), and Stark-shift-induced mixing (speculative). Ways of producing nonfissioning shape isomers are discussed. DOE

N93-28178# Naval Postgraduate School, Monterey, CA.
ENHANCED HIGHER ORDER PARAMETRIC X RADIATION PRODUCTION M.S. Thesis
Kay L. DiNova Dec. 1992 120 p
(AD-A262100) Avail: CASI HC A06/MF A02

This thesis examines parametric x-radiation (PXR) which is the Bragg scattering of the virtual photons associated with the Coulomb field of relativistic charged particle from the atomic planes of a crystal. Higher order parametric x-radiation from the (002) planes of a thick mosaic graphite crystal have been observed. The raw PXR data was collected using a SiLi detector and a Pulse Height Analyzer (PHA) software program. The data was corrected for various effects including attenuation, detector drift, and efficiency. The absolute number of photons per electron was obtained by using the fluorescent x-ray yield from a tin foil backing on the graphite crystal to determine the LINAC current. The number of photons per electron observed greatly exceeds the expected values. Comparison of the ratio of intensity of a given order to the first order I(n)/I(l) to the theoretical ratio shows that the ratios increase with order. Not only is the absolute intensity greater than expected, but the higher orders (compared to the first order) are larger than expected. Lastly, the intensity for various crystal angle orientations and a fixed detector angle was measured. DTIC

N93-28181# Chemical Research and Development Center, Aberdeen Proving Ground, MD.
COMPUTER-ASSISTED DETERMINATION OF MINIMUM ENERGY CONFORMATIONS. 7: A PHARMACOPHORE MODEL OF THE ACTIVE REGION OF THE ALPHA2-ADRENOCEPTOR Final Report, Jun. 1988 - Sep. 1991
William P. Ashman, A. P. Mickiewicz, and Todd M. Nelson Sep. 1992 42 p
(AD-A262108; CRDEC-TR-398) Avail: CASI HC A03/MF A01

Molecular modeling and computational chemistry techniques are used to analyze compounds in developing pharmacophores of biological receptors to use as templates in structure activity relationship studies and to design new chemicals having physiological activity of interest. In this study, the results of x-ray crystal analyses and PM3 semi-empirical molecular orbital conformational analyses are used to determine the three-dimensional representations of selected adrenergic compounds known to be agonists with the alpha2-adrenoceptor in achieving optimized geometries and electrostatic parameters. The alpha2-adrenergic agonists interact with the adrenergic system receptors to produce various increases or decreases in hemodynamic responses (i.e., hypertension, hypotension, and bradycardia) and sedation. A pharmacophore model of the active region of the alpha2-adrenoceptor is described based on the superimposition of common structural, electrostatic, and physicochemical features of the compounds. Using the model to predict compound adrenergic activity and to design alpha2-adrenergic compounds is discussed. DTIC

N93-28198# Rome Univ. (Italy). Dept. of Physics.
A LATTICE COMPUTATION OF THE DECAY CONSTANT OF THE B-MESON
C. R. Allton (Sheffield Univ., England.), C. T. Sachrajda (Sheffield Univ., England.), V. Lubicz (Istituto Nazionale di Fisica Nucleare, Rome, Italy.), L. Maiani (Istituto Nazionale di Fisica Nucleare, Rome, Italy.), and G. Martinelli (Istituto Nazionale di Fisica Nucleare, Rome, Italy.) 9 Jul. 1990 27 p Submitted for publication Sponsored in part by the Ministry of University and Scientific and Technological Research, Italy and United Kingdom Science and Engineering Research Council
(SSCL-Preprint-747; Shep-89/90-11; ETN-93-93640) Avail: CASI HC A03/MF A01

The decay constant of the B-meson, f(sub B), in a 100 by 20 by 40 lattice at beta = 6.0, with Wilson fermions, is computed using 30 gauge field configurations, generated in the quenched approximation. For the propagator of the b-quark only the leading term in the 1/m (sub b) expansion is kept. To improve our results, we use, as the interpolating fields for the B-meson, lattice operators which are 'smeared' over several lattice sites. A signal for the lightest B-meson state is observed and the value f(sub B) = 310 +/- 25 +/- 50 MeV is obtained. This result, combined with earlier lattice measurements of f(sub D) demonstrates that the asymptotic scaling law for the decay constants of heavy pseudoscalar mesons P, has large corrections for charmed mesons. It is estimated that the nonscaling corrections reduce the above value of f(sub B) by about 25%. ESA

N93-28208# Rome Univ. (Italy). Dept. of Physics.
FIRST CALCULATION OF D(+) APPROACHES (K BAR)(*0)e(+)nu(SUB e) IN LATTICE QCD
V. Lubicz, G. Martinelli, and C. T. Sachrajda 11 Jul. 1990 23 p Submitted for publication Sponsored in part by the Ministry of University and Scientific and Technological Research, Italy, and United Kingdom Science and Engineering Research Council
(SSCL-Preprint-748; Shap-89/90-13; ETN-93-93641) Avail: CASI HC A03/MF A01

The results of the calculation of the matrix elements of the quark weak current which are relevant for semileptonic decays of D-mesons into light pseudoscalar and vector mesons are presented. The computations are performed by averaging the results over 15 gauge field configurations, generated in the quenched approximation by the Metropolis algorithm, at beta = 6.0, in a 20 by 10 by 40 lattice, with Wilson fermions. From the study of matrix elements, it is found partial rate for the semileptonic decay of the D(+) into ((K bar)(sup star zero))e(+)nu(sub e) is given by gamma = (5.2 +/- 1.9)10(exp 10)/s and that the ratio of the partial rates (gamma((D(+) decays to (K(sup star zero)e(+)nu(sub e)))/(gamma((D neutral) decays to (K(-)e(+)nu(sub e)))) is given by 1.1 +/- 0.3. The ratio of the longitudinal to transverse polarization rates in (K bar)(sup star zero)

decays is found to be 1.7 +/- 0.6 and is compared to experimental results. Future improvements in the accuracy of our theoretical predictions are discussed. ESA

N93-28213# North Carolina State Univ., Raleigh. Dept. of Physics.
THEORETICAL NUCLEAR REACTION AND STRUCTURE STUDIES USING HYPERONS AND PHOTONS
S. R. Cotanch 1992 7 p
(Contract DE-FG05-88ER-40461)
(DE93-009765; DOE/ER-40461/5) Avail: CASI HC A02/MF A01

Research in three principal areas is summarized: (1) The work on the elementary hadron structure seeks to further the understanding of the hadron structure within the framework of quantum chromodynamics (QCD) and QCD-based models. A comparative study of meson properties employed three relativistic models: an extended Dziembowski model, a generalized light-front approach, and a completely covariant null plane approach. (2) Work on the electromagnetic production of strangeness addressed systems involving the strange quark (hyperons) and hyperon electromagnetic production and radiative capture processes. (3) In the work on medium-energy photonuclear reactions, a large-scale continuum shell-model calculation was performed for ((gamma),N) and (N,(gamma)) reactions at low and medium energies spanning the (Delta) isobar region. DOE

N93-28225# State Univ. of New York, Buffalo. Dept. of Chemistry.
NOVEL GAS PHASE ION MOLECULE REACTIONS OF C60(++) WITH O2
James J. Stry and James F. Garvey 3 Apr. 1993 22 p
(Contract N00014-85-K-0483)
(AD-A262821; TR-40) Avail: CASI HC A03/MF A01

The gas phase ion-molecule chemistry of doubly charged fullerene cations (C(n)++ where n=46,48,...60 and 70) with neutral oxygen molecules, were investigated using a triple quadrupole mass spectrometer. In this paper, we report additions to the fullerene cage structure which result in the formation of C(n)O++, C(n)O2(2+), and C(n)O3(3+) product ions from the C(n)(2+) reagent ion. In addition, we also report charge transfer reactions resulting in the production of C(n)(+) and 02(+) ions, as well as reactive charge transfer reactions generating C(n)O(+) and O3(+). All of these processes are a result of low energy ion-molecule collisions (0.1-24.5 eV sub lab). The normalized intensity of the fullerene products exhibit little dependence on size of fullerene clusters examined. However, the reactivities of the fullerenes are found to be highly dependent on the collision energy and the oxygen pressure within the collision cell. DTIC

N93-28235# Louisiana State Univ., Baton Rouge.
RESEARCH IN ELEMENTARY PARTICLE PHYSICS
L. H. Chan, R. Haymaker, R. Imlay, R. McNeil, W. Metcalf, and R. Svoboda 1992 121 p
(Contract DE-FG05-91ER-40617)
(DE93-009764; DOE/ER-40617/127) Avail: CASI HC A06/MF A02

Theoretical work in the area of effective action expansion of an effective low is presented. Additionally, energy theory of hadrons, dynamical symmetry breaking, and lattice gauge theories are described. The high-energy experimental group at Louisiana State University has analyzed data on a neutrino oscillation experiment at LAMPF. Preparations for the LSND neutrino experiment are stated. IMB data have also been analyzed. For the ZEUS electron n-proton colliding beam experiment, the fabrication of the barrel calorimeter has been completed. Several modules of the calorimeter have been tested at Fermilab, and preparations for data taking are underway. DOE

N93-28246# Minnesota Univ., Minneapolis. Dept. of Chemical Engineering and Materials Science.
STRUCTURE AND THERMODYNAMICS OF THE SOFT ION MODEL ELECTROLYTE SOLUTIONS
Lianrui R. Zhang, Henry S. White, and H. T. Davis 20 Mar. 1993 21 p
(Contract N00014-91-J-1927)
(AD-A262293; TR-19) Avail: CASI HC A03/MF A01

A soft ion (SI) model of 1:1 electrolytes (0.1 to 5 molar concentration) has been studied by Grand Canonical Monte Carlo (GCMC) simulations and hypernetted chain (HNC) integral equation theory. Pair correlation functions, osmotic pressure, and mean activity coefficients have been calculated as a function of the repulsive soft core potential tau-n for N = 9 and 12 (soft ions) and N = infinity (hard ions). Results obtained by HNC theory for different electrolyte concentrations and soft core potentials are in excellent agreement with GCMC simulations. At high electrolyte concentration (greater than 1.0 M), the thermodynamic properties and pair correlation functions of the electrolytes are strongly dependent on v. Activity coefficients obtained with a soft core repulsion potential are in good agreement with experimental data for 1:1 electrolytes. Comparison of GCMC results obtained using the minimum image (MI) and Ewald summation methods indicate that the less expensive MI method gives satisfactory results for medium to high electrolyte concentration. DTIC

N93-28292# University of Northern Illinois, De Kalb. Dept. of Chemistry.
TRANSPORT OF Zn(OH)4(-2) IONS ACROSS A POLYOLEFIN MICROPOROUS MEMBRANE
Ivan Krejci, Peter Vanysek, and Antonin Trojanek 7 Apr. 1993 22 p
(Contract N00014-91-J-1058)
(AD-A262969; TR-050) Avail: CASI HC A03/MF A01

Transport of ZN(OH)4(2-) ions through modified microporous polypropylene membranes (Celgard 3401, 350140) was studied using polarography and conductometry. Soluble Nafion as an ion exchange modifying agent was applied to the membrane by several techniques. The influence of Nafion and a surfactant on transport of zinc ions through the membrane was studied. A relationship between membrane impedance and the rate of Zn(OH)4(2-) transport was found. The found correlation between conductivity, ion permeability and Nafion coverage suggests a suitable technique of membrane preparation to obtain desired zinc ion barrier properties. DTIC

N93-28298# Oak Ridge National Lab., TN.
RADIATION INTERACTION AND DETECTION PRINCIPLES
J. E. Turner 1992 23 p Presented at the Modern Methods in Radiation Measurements and Dosimetry Training Course, Bad Honnef, Germany, 23-27 Nov. 1992
(Contract DE-AC05-84OR-21400)
(DE93-005302; CONF-9211160-1) Avail: CASI HC A03/MF A01

Part 1 of this presentation describes the interactions of different types of ionizing radiation with matter and the principal physical processes for energy loss. Part 2 discusses these phenomena as the basis for various methods of detecting and measuring ionizing radiation. DOE

N93-28301# Brookhaven National Lab., Upton, NY.
STUDIES OF STRUCTURAL DAMAGE IN HIGH-T(SUB c) SUPERCONDUCTORS BY HIGH-ENERGY HEAVY-ION IRRADIATION
Yimei Zhu, Z. X. Cai, R. C. Budhani, D. O. Welch, and M. Suenaga 1992 4 p Presented at the 5th United States/Japan Workshop on High Tc Superconductors, Tsukuba, Japan, 9-10 Nov. 1992
(Contract DE-AC02-76CH-00016)
(DE93-005579; BNL-48164; CONF-9211144-4) Avail: CASI HC A01/MF A01

The results of studies of structural damage by high-energy (MeV) Si(sup +13), Cu(sup +18), Ag(sup +21), and Au(sup +24) ions, using transmission electron microscopy techniques, revealed that the size of the damaged area (amorphous) is strongly dependent on: (1) the stopping power (dE/dx (keV/nm)) of the irradiating ions, (2) the thermal diffusivity of the crystal, (3) the degree of oxygenation, in the case of YBa2Cu3O(7-delta), and (4) the direction of the ion beam with respect to the crystallographic axis. DOE

N93-28310# Brookhaven National Lab., Upton, NY.
STRONG-FIELD DISSOCIATION DYNAMICS
L. F. DiMauro and Baorui Yang 1993 11 p Presented at the International Society for Optical Engineering (SPIE) Conference, Los Angeles, CA, 16-23 Jan. 1993
(Contract DE-AC02-76CH-00016)
(DE93-006671; BNL-48488; CONF-930159-6) Avail: CASI HC A03/MF A01

The strong-field dissociation behavior of diatomic molecules is examined under two distinctive physical scenarios. In the first scenario, the dissociation of the isolated hydrogen and deuterium molecular ions is discussed. The dynamics of above-threshold dissociation (ATD) are investigated over a wide range of green and infrared intensities and compared to a dressed-state model. The second situation arises when strong-field neutral dissociation is

followed by ionization of the atomic fragments. The study results in a direct measure of the atomic fragment's ac-Stark shift by observing the intensity-dependent shifts in the electron or nuclear fragment kinetic energy. DOE

N93-28331# Oak Ridge National Lab., TN.
TWO-PROTON CORRELATIONS FROM HEAVY-ION COLLISIONS: DETERMINING THE REACTION ZONE OF Ni + Ni BY THE HANBURY-BROWN-TWISS EFFECT
N. Cindro (Institut Rudjer Boskovic, Zagreb, Yugoslavia.), M. Korolija (Institut Rudjer Boskovic, Zagreb, Yugoslavia.), and D. Shapira 1992 9 p Presented at the International School of Nuclear Physics on Heavy Ion Collisions At Intermediate and Relativistic Energies, Sicily, Italy, 7-16 Sep. 1992
(Contract DE-AC05-84OR-21400)
(DE93-008971; CONF-9209306-2) Avail: CASI HC A02/MF A01

A brief description of the application of the Hanbury-Brown-Twiss effect for determining the space-time structure of the emitting source in a nucleus-nucleus collisions is given. In this context, a measurement of exclusive p-p correlations from Ni-58 + Ni-58 at 850 MeV is presented. Enhancement of the correlation functions for small value of delta-p when a gate is applied to the relative velocity, vrel, has been interpreted in terms of stochastic proton emission followed by the p-p final state interaction and the size and the lifetime of the proton-emitting source deduced. A dependence of the p-p correlation function on the delta-p orientation has been found and ascribed to angular momentum effects on the correlation function. DOE

N93-28356# Houston Univ., TX. Dept. of Physics.
SELECTED PROBLEMS IN EXPERIMENTAL INTERMEDIATE ENERGY PHYSICS
B. W. Mayes, E. V. Hungerford, and L. S. Pinsky Sep. 1992 33 p
(Contract DE-FG05-88ER-40419)
(DE93-007300; DOE/ER-40419/01) Avail: CASI HC A03/MF A01

Objectives of this research program are to investigate forefront problems in experimental intermediate-energy physics, educate students in this field of research, and develop the instrumentation necessary. Generally, this research is designed to search for physical processes that cannot be explained by conventional models of elementary interactions. The program has three major thrusts: strange particle physics, where a strange quark is embedded in the nuclear medium; muon electro-weak decay, which involves a search for a violation of the standard model of the electro-weak interaction; and measurement of the spin-dependent structure function of the neutron. Current research is reported in the following areas: hyperon physics at the AGS, electroproduction of hypernuclei, test of the standard model of electro-weak interactions, spin structure function of nucleons, and instrumentation. DOE

N93-28358# Texas Univ., Austin. Dept. of Physics.
MEDIUM ENERGY MEASUREMENTS ON N-N PARAMETERS
D. Ambrose, M. Bachman, P. Coffey, G. Glass, B. Jobst, K. H. McNaughton, C. Nguyen, and P. J. Riley Dec. 1992 61 p
(Contract DE-FG05-88ER-40446)
(DE93-007304; DOE/ER-40446/5) Avail: CASI HC A04/MF A01

Research is reported on the following topics: Spin transfer measurements in np elastic scattering; pp elastic differential cross section measurements; single pion production in np scattering; and a new search for rare kaon decays (K(sub L)(yields)(mu)(mu) and K(sub L)(yields)ee). DOE

N93-28359# Boston Univ., MA. Dept. of Chemistry.
STUDY OF INTERMEDIATES FROM TRANSITION METAL EXCITED-STATE ELECTRON-TRANSFER REACTIONS
M. Z. Hoffman 31 Mar. 1993 5 p
(Contract DE-FG02-86ER-13603)
(DE93-010904; DOE/ER-13603/7) Avail: CASI HC A01/MF A01

Progress on 6 projects is reported: excited state absorption spectrum of Ru(bpy)(3)(sup 2+), solvent cage model for electron transfer quenching, reductive quenching of (sup *)Cr(III) complexes, solution medium effects in oxidative quenching of (sup *)Ru(II) complexes, photosensitized oxidation of phenol in aqueous solution, and quenching of Ru(II) complexes by oxygen. DOE

N93-28368# Ohio Univ., Athens. Inst. of Nuclear and Particle Physics.
THEORY OF PHOTON AND ELECTRON INDUCED REACTIONS
D. S. Onley and L. E. Wright Jan. 1993 26 p
(Contract DE-FG02-87ER-40370)
(DE93-005925; DOE/ER-40370/5) Avail: CASI HC A03/MF A01

Theoretical work is reported on the following topics: photo- and electroproduction of mesons by the (gamma),(pi)(exp -p) reactions on C-12 and O-16; Coulomb distortion effects on (e,e'(gamma)) and on inclusive (e,e') and exclusive (e,e'p) scattering in the quasi-elastic region for Ca-40, Pb-208, and U-238; relativistic structure calculations in which the basic Lagrangian is an extension of the (sigma)(endash)(omega) model in which the nucleons are coupled to five fields ((sigma), (omega), (rho), (pi), and the electromagnetic field) and tensor coupling to the vector mesons (rho) and (omega) is also considered; and an investigation of the interaction (gamma) + p (yields) K(+) + (Lambda)(sup 0) in a simple quark model that supplies the coupling constants and form factors associated with each vertex in the Feynman diagrams. DOE

N93-28375# Physical Sciences, Inc., Andover, MA.
ENERGY TRANSFER STUDIES IN INTERHALOGEN MOLECULES Final Report, 15 Aug. 1989 - 19 Nov. 1992
S. J. Davis, K. W. Holtzclaw, W. J. Kessler, and L. G. Piper Jan. 1993 59 p
(Contract F49620-89-C-0101)
(AD-A262888; PSI-1085/TR-1237; AFOSR-93-0167TR) Avail: CASI HC A04/MF A01

Energy transfer processes in interhalogen molecules that have potential for visible chemical laser development are examined. Spectrally resolved laser induced fluorescence is used to determine rotation-to-translation (R-T) and vibration-to-translation (V-T) rate coefficients. Several fitting laws for R-T transfer to data obtained for IF and ICl interactions with several collision partners are reported. Preliminary data on V-T relaxation within the ground electronic state of IF are also obtained. Preliminary results of an optically-pumped HF laser are also presented. DTIC

N93-28388# Rome Univ. (Italy). Dept. of Physics.
LEADING NON-LOGARITHMIC CONTRIBUTION TO THE ELECTROPENGUIN DIAGRAM AND PHENOMENOLOGY OF KAON DECAYS
M. Ciuchini (Istituto Nazionale di Fisica Nucleare, Rome, Italy.), E. Franco (Istituto Nazionale di Fisica Nucleare, Rome, Italy.), and R. Onofrio (Istituto Nazionale di Fisica Nucleare, Rome, Italy.) 13 Jun. 1990 15 p Submitted for publication
(SSCL-Preprint-745; ETN-93-93638) Avail: CASI HC A03/MF A01

The leading nonlogarithmic contribution which arises in the real part of the Wilson coefficient for the electropenguin operator is reanalyzed within the four flavor effective hamiltonian. The ratio (gamma(K(+) decays to pi(+)e(+)e(-)))/gamma(K(+) decays to pi neutral e(+)nu(sub e))), the K(sub L) rate decay to pi neutral e(plus)e(minus) and the delta I = 1/2 rule in nonleptonic kaon decays are reconsidered by taking to account both the leading nonlogarithmic contribution and the strong corrections in M(sub w)/mu) squared up to the next-to-leading order. Their dependence on the quantum chromodynamics parameters is studied and it is argued that the inclusion of the strong corrections of order log (m(sub g)/mu) squared cannot be neglected. ESA

N93-28398# Colorado State Univ., Fort Collins. Dept. of Chemistry.
ELECTRON TRANSFER, PROTON TRANSFER AND PHOTOADDITION REACTIONS IN ISOLATED CLUSTERS Final Report, Sep. 1991 - Dec. 1992
Elliot R. Bernstein 1 Feb. 1993 12 p
(Contract N00014-89-J-1237)
(AD-A262719) Avail: CASI HC A03/MF A01

This report contains the abstracts of the published and to be published papers from this work. They include studies of the structure of nonrigid molecules, the formation of clusters and dimers, liquid cluster structure, chemical reaction studies, and studies of cluster dynamics. DTIC

N93-28463# Los Alamos National Lab., NM.
QUASICLASSICAL APPROACH TO IONIZATION OF ATOMS BY STRONG LASER PULSES: THE COMPARISON WITH THE SIMPLEMAN'S MODELS AND NEWTONIAN DYNAMICS

P. B. Lerner, K. LaGattuta, and J. S. Cohen 1993 13 p Presented at the Third SILAP Conference, Hansui, Belgium, 8-14 Jan. 1993
(Contract W-7405-eng-36)
(DE93-008738; LA-UR-93-635; CONF-930184-1) Avail: CASI HC A03/MF A01

We study the energy spectrum of the ionized electrons and compare it to the results of 'naive' theories of multiphoton ionization of atoms. These 'naive' or 'simpleman's' theories have demonstrated quite a spectacular success in the recent past, being a basis for explanation of the most observed experimental results. Our study also present a testing ground for what classical and semiclassical theories can and cannot explain. DOE

N93-27335*# Maryland Univ., College Park. Dept. of Physics.
REMARKS ABOUT MASSIVE AND MASSLESS PARTICLES IN SUPERSYMMETRY
S. V. Ketov and Y.-S. Kim *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 255-260 (For primary document see N93-27311 10-74)
Avail: CASI HC A02/MF A04

N93-28281*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
ATOMIC OXYGEN EFFECTS ON LDEF EXPERIMENT AO171
Ann F. Whitaker, Rachel R. Kamenetzky, Miria M. Finckenor, and Joseph K. Norwood *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 1125-1135 (For primary document see N93-28254 10-99)
Avail: CASI HC A03/MF A04; 2 functional color pages

73 NUCLEAR AND HIGH-ENERGY PHYSICS

Includes elementary and nuclear particles; and reactor theory. For space radiation see *93 Space Radiation.*

N93-26905*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
DESCRIPTION OF ALPHA-NUCLEUS INTERACTION CROSS SECTIONS FOR COSMIC RAY SHIELDING STUDIES
Francis A. Cucinotta, Lawrence W. Townsend, and John W. Wilson Washington Apr. 1993 44 p
(RTOP 593-42-21-01)
(NASA-TP-3285; L-17139; NAS 1.60:3285) Avail: CASI HC A03/MF A01

Nuclear interactions of high-energy alpha particles with target nuclei important for cosmic ray studies are discussed. Models for elastic, quasi-elastic, and breakup reactions are presented and compared with experimental data. Energy-dependent interaction cross sections and secondary spectra are presented based on theoretical models and the limited experimental data base. Author

N93-27031*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
HZEFRG1: AN ENERGY-DEPENDENT SEMIEMPIRICAL NUCLEAR FRAGMENTATION MODEL
Lawrence W. Townsend, John W. Wilson, Ram K. Tripathi (Vigyan Research Associates, Inc., Hampton, VA.), John W. Norbury (Rider Coll., Lawrenceville, NJ.), Francis F. Badavi (Christopher Newport Coll., Newport News, VA.), and Ferdous Khan (Old Dominion Univ., Norfolk, VA.) Washington May 1993 64 p
(RTOP 593-42-21-01)
(NASA-TP-3310; L-17161; NAS 1.60:3310) Avail: CASI HC A04/MF A01

Methods for calculating cross sections for the breakup of high-energy heavy ions by the combined nuclear and coulomb fields of the interacting nuclei are presented. The nuclear breakup contributions are estimated with an abrasion-ablation model of heavy ion fragmentation that includes an energy-dependent, mean free path. The electromagnetic dissociation contributions arising from the interacting coulomb fields are estimated by using Weizsacker-Williams theory extended to include electric dipole and electric quadrupole contributions. The complete computer code that implements the model is included as an appendix. Extensive comparisons of cross section predictions with available experimental data are made. Author

N93-27110*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
COMPARISONS OF CROSS-SECTION PREDICTIONS FOR RELATIVISTIC IRON AND ARGON BEAMS WITH SEMIEMPIRICAL FRAGMENTATION MODELS
Lawrence W. Townsend, Ram K. Tripathi (Vigyan Research Associates, Inc., Hampton, VA.), and Ferdous Khan (Old Dominion Univ., Norfolk, VA.) Washington May 1993 13 p
(RTOP 199-45-16-11)
(NASA-TM-4462; L-17213; NAS 1.15:4462) Avail: CASI HC A03/MF A01

Cross-section predictions with semi-empirical nuclear fragmentation models from the Langley Research Center and the Naval Research Laboratory are compared with experimental data for the breakup of relativistic iron and argon projectile nuclei in various targets. Both these models are commonly used to provide fragmentation cross-section inputs into galactic cosmic ray transport codes for shielding and exposure analyses. Overall, the Langley model appears to yield better agreement with the experimental data. Author

N93-27111*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
OPTICAL MODEL CALCULATIONS OF 14.6A GeV SILICON FRAGMENTATION CROSS SECTIONS
Lawrence W. Townsend, Ferdous Khan (Old Dominion Univ., Norfolk, VA.), and Ram K. Tripathi (Vigyan Research Associates, Inc., Hampton, VA.) Washington May 1993 14 p
(RTOP 199-45-16-11)
(NASA-TM-4461; L-17216; NAS 1.15:4461) Avail: CASI HC A03/MF A01

An optical potential abrasion-ablation collision model is used to calculate hadronic dissociation cross sections for a 14.6 A GeV(exp 28) Si beam fragmenting in aluminum, tin, and lead targets. The frictional-spectator-interaction (FSI) contributions are computed with two different formalisms for the energy-dependent mean free path. These estimates are compared with experimental data and with estimates obtained from semi-empirical fragmentation models commonly used in galactic cosmic ray transport studies. Author

N93-27259*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
CAN BOSE CONDENSATION OF ALPHA PARTICLES BE OBSERVED IN HEAVY ION COLLISIONS?
Ram K. Tripathi (Christopher Newport Coll., Newport News, VA.) and Lawrence W. Townsend Jun. 1993 17 p
(RTOP 199-45-16-11)
(NASA-TM-108996; NAS 1.15:108996) Avail: CASI HC A03/MF A01

Using a fully self-consistent quantum statistical model, we demonstrate the possibility of Bose condensation of alpha particles with a concomitant phase transition in heavy ion collisions. Suggestions for the experimental observation of the signature of the onset of this phenomenon are made. Author

N93-28058# Sandia National Labs., Albuquerque, NM.
RADIONUCLIDE INVENTORIES FOR SHORT RUN-TIME SPACE NUCLEAR REACTOR SYSTEMS
R. L. Coats 22 Oct. 1992 12 p Presented at the 10th Symposium on Space Nuclear Power and Propulsion, Albuquerque, NM, 10-14 Jan. 1993
(Contract DE-AC04-76DP-00789)
(DE93-004040; SAND-92-2353C; CONF-930103-25) Avail: CASI HC A03/MF A01

Space Nuclear Reactor Systems, especially those used for propulsion, often have expected operation run times much shorter than those for land-based nuclear power plants. This produces substantially different radionuclide inventories to be considered in the safety analyses of space nuclear systems. This presentation describes an analysis utilizing ORIGEN2 and DKPOWER to provide comparisons among representative land-based and space systems. These comparisons enable early, conceptual

considerations of safety issues and features in the preliminary design phases of operational systems, test facilities, and operations by identifying differences between the requirements for space systems and the established practice for land-based power systems. Early indications are that separation distance is much more effective as a safety measure for space nuclear systems than for power reactors because greater decay of the radionuclide activity occurs during the time to transport the inventory a given distance. In addition, the inventories of long-lived actinides are very low for space reactor systems. DOE

N93-28203# Oesterreichisches Forschungszentrum Seibersdorf G.m.b.H., Vienna. Hauptabt. Energie- und Anlagentechnik.

AUSTRIAN CONTRIBUTIONS TO REACTOR SAFETY RESEARCH [OESTERREICHISCHE BEITRAEGE ZUR REAKTORSICHERHEITSFORSHUNG: EIN UEBERBLICK]

Gert Sdouz Mar. 1992 42 p In GERMAN Presented at Atominstitut der Oesterreichischen Univ., 23 Mar. 1992

(OEFZS-4622; ETN-93-93449) Copyright Avail: CASI HC A03/MF A01

An overview of Austrian contributions to reactor safety research is given. Starting with licensing for the power plant Zwenkendorf and participation in the safety projects PBF (Power Burst Facility) and LOFT (Loss Of Fluid Test), the work shifted later to participation in the study of international standard problems of the OECD and the IAEA. Since 1988 the center of activity is the calculation of the source term behavior of accident sequences, especially for reactors of Russian types. As an illustration the results of a source term calculation for a TMLB' sequence are presented. ESA

N93-28215# Oregon State Univ., Corvallis.

THEORETICAL STUDIES IN NUCLEAR PHYSICS Progress Report, 1 May 1991 - 30 Apr. 1992

Rubin H. Landau and Victor A. Madsen 1992 28 p

(Contract DE-FG06-86ER-40283)

(DE93-010142; DOE/ER-40283/13) Avail: CASI HC A03/MF A01

Work in nuclear structure and reaction theory, specifically, the relation of reactions to the nuclear structure, is discussed. Other work was done in intermediate energy physics, few-body problems, and computational physics. DOE

N93-28330# Fermi National Accelerator Lab., Batavia, IL.

THE EFFECT OF CHROMATIC DECOHERENCE ON TRANSVERSE INJECTION OSCILLATION DAMPING

Gerald P. Jackson Jan. 1993 16 p Presented at the Workshop on Feedback Control of Multi-Bunch Instabilities, Erice, Italy, 16 Nov. 1992

(Contract DE-AC02-76CH-03000)

(DE93-008876; FNAL/C-93/010; CONF-9211200-2) Avail: CASI HC A03/MF A01

In order to eliminate or reduce transverse emittance growth during transfers between accelerators, transverse damper systems are used to eliminate residual dipole oscillations before phase space dilution takes place. In transfers where the target accelerator has high chromaticity or the beam has a large momentum spread, phase space dilution due to chromatic decoherence can take place on a scale short compared to the damping time of the transverse injection oscillation damper. The effect of the damper on the beam phase space is not clear while the coherent oscillation is suppressed by this decoherence. The purpose of this paper is to quantify the effectiveness of dampers at eliminating emittance blowup at transfers in the presence of chromatic decoherence. DOE

N93-28337# Nationaal Inst. voor Kernfysica en Hoge Energiefysica, Amsterdam (Netherlands).

NIKHEF-K CONTRIBUTIONS TO THE 3RD EUROPEAN PARTICLE ACCELERATOR CONFERENCE

1992 19 p Conference held in Berlin, Germany, 24-28 Mar. 1992

(NIKHEF-AmPS-92-02; ETN-93-93536) Avail: CASI HC A03/MF A01

Development studies and improvements performed in the Amsterdam Pulse Stretcher (AmPS) are summarized. The following subjects are discussed: the AmPS as a photon source RV electrostatic wire septum; the pulsed electrostatic kickers with low beam impedance; high power; the mechanical design and construction of the AmPS; the 80 kV electrostatic wire septum; the pulsed electrostatic kickers with low beam impedance; high power density magnetic septa; and the improvements at the 400 kV linear accelerator electron source. For individual titles, see N93-28338 through N93-28343.

N93-28338# Nationaal Inst. voor Kernfysica en Hoge Energiefysica, Amsterdam (Netherlands).

THE AMSTERDAM PULSE STRETCHER AmPS AS A PHOTON SOURCE

R. Maas and G. Luijckx *In its* NIKHEF-K Contributions to the 3rd European Particle Accelerator Conference 1992 3 p (For primary document see N93-28337 10-73)

Avail: CASI HC A01/MF A01

The synchrotron radiation properties of the Amsterdam Pulse Stretcher (AmPS) and the design for a modified ring lattice are presented. The electron pulse stretcher/storage ring started delivering nearly continuous electron beams of maximum 900 MeV in Spring 1992. The extracted beam as well as the stored beam are to be used for nuclear physics purposes for about 2500 hours/year. For the remaining time of the year, AmPS could be used as a dedicated photon source covering the spectrum from infrared up to soft X-rays. ESA

N93-28339# Nationaal Inst. voor Kernfysica en Hoge Energiefysica, Amsterdam (Netherlands).

MECHANICAL DESIGN PHILOSOPHY AND CONSTRUCTION OF THE AMSTERDAM PULSE STRETCHER RING AmPS

A. P. Kaan, J. A. Heemskerk, J. Touw, J. Bijleveld, H. Boer Rookhuizen, W. Verlegh, J. Langedijk, G. Bron, R. Arink, and P. Lassing *In its* NIKHEF-K Contributions to the 3rd European Particle Accelerator Conference 1992 3 p Sponsored by Stichting voor Fundamenteel Onderzoek der Materie and Netherlands Organization for Applied Scientific Research (For primary document see N93-28337 10-73)

Avail: CASI HC A01/MF A01

The design philosophy and the construction of the Amsterdam Pulse Stretcher (AmPS) are described with emphasis on the vacuum components as well as on the alignment system and on the supports for the magnets and the monitors. The AmPS ring is a 900 MeV electron pulse stretcher and storage ring with a circumference of 212 m. The ring was planned to start in Spring 1992. The vacuum chambers in the bending sections therefore are fabricated from stainless steel 316 LN with a very low cobalt content. An advanced welding and cleaning technique was developed to avoid the inclusion of impurities. The vacuum pump capacity and the pump distribution along the ring were optimized as function of local conductances and outgassing. ESA

N93-28340# Nationaal Inst. voor Kernfysica en Hoge Energiefysica, Amsterdam (Netherlands).

THE 80 kV ELECTROSTATIC WIRE SEPTUM FOR AmPS

A. vanderLinden, J. H. M. Bijleveld, H. Boer Rookhuizen, P. J. T. Bruinsma, E. Heine, P. Lassing, and E. Prins *In its* NIKHEF-K Contributions to the 3rd European Particle Accelerator Conference 1992 3 p Sponsored by Stichting voor Fundamenteel Onderzoek der Materie (For primary document see N93-28337 10-73)

Avail: CASI HC A01/MF A01

The characteristics of the wire septum for the Amsterdam Pulse Stretcher (AmPS) are summarized. In the extraction process of the AmPS the extracted beam is intercepted from the circulating beam by the 1 m long electrostatic wire septum. For a bending angle of 4.4 mrad, the maximum anode voltage is 80 kV. The system developed consists of a wire spacing of 0.65 mm between tungsten wires of 50 micrometers diameter. Stainless steel spring wires, bent in a half cylindrical carrier, stretch the septum wires two by two. Prototype tests were successful up to an anode voltage of 120 kV. ESA

N93-28341# Nationaal Inst. voor Kernfysica en Hoge Energiefysica, Amsterdam (Netherlands).

PULSED ELECTROSTATIC KICKERS WITH LOW BEAM IMPEDANCE FOR AmPS

E. Heine, A. vanderLinden, J. H. M. Bijleveld, P. J. T. Bruinsma, J. J. Kuijt, and P. F. Timmer *In its* NIKHEF-K Contributions to the 3rd European Particle Accelerator Conference 1992 3 p Sponsored by Stichting voor Fundamenteel Onderzoek der Materie (For primary document see N93-28337 10-73)

Avail: CASI HC A01/MF A01

The characteristics of the pulsed electrostatic kickers for the Amsterdam Pulse Stretcher (AmPS) are presented. During 3 turns injection into AmPS, two identical electrostatic kickers create a local vertical displacement of the closed orbit of the ring by a 2.75 mrad bend. Within 10 microseconds, the 1570 mm long parallel plates of the kickers are charged to + and - 35 kV by a triode switch. The fast discharge of the plates, required at the end of the injection cycle of 2.1 microseconds, is achieved by using very fast thyratrons. A discharge time of less than 100 ns is shown in bench tests. The synchronous discharge of the two kickers requires a timing error of less than 1 ns. Timing jitter is reduced by the improved stability of the thyratron adjustments. The measured longitudinal broadband impedance (Z/n) of the kicker is (0.21 +/- 0.05) omega. ESA

N93-28342# Nationaal Inst. voor Kernfysica en Hoge Energiefysica, Amsterdam (Netherlands).
HIGH POWER DENSITY, THIN MAGNETIC DC SEPTA FOR AmPS
A. vanderLinden, J. H. M. Bijleveld, H. Boer Rookhuizen, P. J. T. Bruinsma, M. Doets, P. Lassing, and C. Zegers *In its* NIKHEF-K Contributions to the 3rd European Particle Accelerator Conference 1992 3 p Sponsored by Stichting voor Fundamenteel Onderzoek der Materie (For primary document see N93-28337 10-73)
Avail: CASI HC A01/MF A01

The direct current (d.c.) magnetic extraction and injection septums for the Amsterdam Pulse Stretcher (AmPS) are presented. The 400 mm long injection septum, located inside the ring vacuum, requires 1075 A in its winding to generate the maximum field of 0.135 T. The steptum thickness at the exit is restricted to 3 mm. The septum is cooled indirectly by using ceramic enamel of 0.2 mm thickness for electrical insulation. Tests at 1 kA in vacuum show a 80 C temperature rise of the winding due to the 300 W dissipation. The heat conductivity of ceramic enamel is at least 0.2 W/m.C. The stray field is measured to be at maximum 8 Gauss at 850 A. The 700 nm long extraction septum is outside the vacuum and consists of 2 turns to generate a maximum field of 0.271 T at 2160 A. The septum thickness is 5 mm at the entrance. Water cooling is required for the maximum dissipation of 2 kW/m. The mean temperature rise of the windings is measured to be 2.5 C at 1060 A. The maximum integrated stray field at 750 A is measured to be 0.3 mT.m. ESA

N93-28343# Nationaal Inst. voor Kernfysica en Hoge Energiefysica, Amsterdam (Netherlands).
IMPROVEMENT OF THE 400 kV LINAC ELECTRON SOURCE OF AmPS
F. B. Kroes, M. G. vanBeuzekom, N. J. Dobbe, J. T. vanEs, P. P. M. Jansweijer, A. H. Kruijer, G. Luigjes, and T. G. B. Sluijk *In its* NIKHEF-K Contributions to the 3rd European Particle Accelerator Conference 1992 3 p Sponsored by Stichting voor Fundamenteel Onderzoek der Materie and Netherlands Foundation for Applied Scientific Research (For primary document see N93-28337 10-73)
Avail: CASI HC A01/MF A01

The improvements introduced in the 900 MeV Amsterdam Pulse Stretcher (AmPS) are summarized. The linear accelerator peak current increased from 20 to 80 mA. The 400 kV low emittance gun was modified. The increased space charge forces in the beam required stronger electrostatic focusing in the first electrostatic gap to define the beam diameter at the gun exit. This was accomplished with a 25 kV controlled power supply. A build in microprocessor coupled to the local computer by optical fibers, was used to monitor and control the gun parameters. The 5 kV gun extractor voltage pulse shape can be monitored by means of an analog fiber transducer with build in calibration. In order to improve the energy stability of the accelerated electrons, a serial electron tube stabilizer was added to the 400 kV power supply. A supply stability of 200,000 was achieved. ESA

N93-28353# Ames Lab., IA.
INTERMEDIATE/HIGH ENERGY NUCLEAR PHYSICS
J. P. Vary 1992 37 p
(Contract DE-FG02-87ER-40371)
(DE93-005927; DOE/ER-40371/6) Avail: CASI HC A03/MF A01

Progress during the last year is reviewed under the following topics: relativistic hadron-nucleus and nucleus-nucleus collisions (heavy meson production, photon production and fragmentation functions-direct photon production with the QCM and photon fragmentation functions, Cronin effect and multiple scattering, effective nuclear parton distributions); solving quantum field theories in a nonperturbative regine; light-front dynamics and high-spin states (soft form factor of the pionand nucleon for transverse and longitudinal momentum transfers, and light front spinors for high-spin objects); high-energy spin physics; relativistic wave equations, quarkonia, and e(+)e(-) resonances; and associated production of Higgs bosons at collider energies, and microscopic nuclear many-body theory and reactions. DOE

N93-28357# Louisiana State Univ., Baton Rouge. Dept. of Physics and Astronomy.
NUCLEAR INTERACTIONS IN HIGH ENERGY HEAVY IONS AND APPLICATIONS IN ASTROPHYSICS
J. P. Wefel and T. G. Guzik 11 Jan. 1993 95 p
(Contract DE-FG05-84ER-40147)
(DE93-007302; DOE/ER-40147/11) Avail: CASI HC A05/MF A01

The overall objective is to study the mechanisms and the energy dependence of heavy ion fragmentation by studying the reactions of heavy ion projectiles (e.g. He-4, O-16, Ne-20, Si-28, and Fe-56) in a variety of targets (H, He, C, Si, Cu, and Pb) and at a number of beam energies exceeding 0.1 GeV/nucleon. The results have application to questions in high-energy nuclear astrophysics. Most of the discussion is on low-energy O-16 and Si-28 data analysis. The description includes analysis procedures and techniques, detector calibrations, data selections and normalizations. Cross section results for the analysis are also presented. DOE

N93-28367# University of Northern Illinois, De Kalb.
STUDIES OF HIGH ENERGY PHENOMENA USING MUONS
David Hedin, Daniel Kaplan, and James Green Feb. 1993 19 p
(Contract DE-FG02-91ER-40641)
(DE93-009373; DOE/ER-40641/2) Avail: CASI HC A03/MF A01

The NIU high energy physics group has three main efforts. The first is the D0 experiment at the Fermilab proton-antiproton collider, with major emphasis on its muon system. The second is the involvement of a portion of the group in Fermilab Experiment 789. Finally, members of the group participate in the SDC collaboration at the SSC. DOE

N93-28429# Superconducting Super Collider Lab., Dallas, TX.
EXPERIMENTAL CHALLENGES AT FUTURE HADRON COLLIDERS (LECTURES FOR THE 1992 SAINT CROIX SUMMER SCHOOL)
J. Siegrist Oct. 1992 40 p Presented at the 1992 Saint Croix Summer School, Saint Croix, Virgin Islands, 15-18 Jul. 1992 Submitted for publication
(Contract DE-AC35-89ER-40486)
(DE93-008613; SSCL-Preprint-159; CONF-9207184-1) Avail: CASI HC A03/MF A01

An overview of the experimental program at future hadron colliding beam machines is presented. Special emphasis is given to the Tevatron upgrade program and Superconducting Super Collider physics with the detector designed by the Solenoidal Detector Collaboration (SDC). Expected physics reach of the new machines is outlined. Expected physics performance of the proposed SDC design is detailed. DOE

N93-26934*# Massachusetts Inst. of Tech., Cambridge. Dept. of Aeronautics and Astronautics.
FLOW INSTABILITY IN PARTICLE-BED NUCLEAR REACTORS
Jack L. Kerrebrock *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 1 1993 p 498-506 (For primary document see N93-26908 10-20)
Avail: CASI HC A02/MF A04

N93-26935*# Los Alamos National Lab., NM.
NUCLEAR PROPULSION TECHNOLOGY ADVANCED FUELS TECHNOLOGY
Walter A. Stark, Jr. *In* NASA. Lewis Research Center, Nuclear Propulsion Technical Interchange Meeting, Volume 1 1993 p 507-519 (For primary document see N93-26908 10-20)
Avail: CASI HC A03/MF A04

74 OPTICS

Includes light phenomena; and optical devices.
For lasers see *36 Lasers and Masers.*

N93-27073*# Texas A&M Univ., College Station. Dept. of Electrical Engineering.
MODULATION AND CODING FOR THROUGHPUT-EFFICIENT OPTICAL FREE-SPACE LINKS
Costas N. Georghiades 1993 28 p
(Grant NAG3-1353; TEES Proj. 32525-41230)
(NASA-CR-193079; NAS 1.26:193079) Avail: CASI HC A03/MF A01

Optical direct-detection systems are currently being considered for some high-speed inter-satellite links, where data-rates of a few hundred megabits per second are evisioned under power and pulsewidth constraints. In this paper we investigate the capacity, cutoff-rate and error-probability performance of uncoded and trellis-coded systems for various modulation schemes and under various throughput and power constraints. Modulation schemes considered are on-off keying (OOK), pulse-position modulation (PPM), overlapping PPM (OPPM) and multi-pulse (combinatorial) PPM (MPPM). Author

N93-27225*# Arizona Univ., Tucson.
DEVELOPMENT OF FAR INFRARED DETECTION TECHNIQUES
Technical Progress Report, 1 Jan. - 31 Mar. 1993
George Rieke 3 Jun. 1993 9 p
(Grant NAGw-2864)
(NASA-CR-193153; NAS 1.26:193153; ITAP-0008) Avail: CASI HC A02/MF A01

This grant supports the development of a variety of advanced far infrared detection techniques that will be used in future NASA missions such as the Space Infrared Telescope Facility (SIRTF). These studies span the wavelength region of 30-200 microns and include development of focal planes and electronics that would utilize them. Efforts reported here represent collaborations among the University of Arizona's Steward Observatory; Lawrence Berkeley Laboratories (LBL); and the University of California at Berkeley. The overall goal of this program is to demonstrate extremely high performance detectors for low background applications between 30-200 microns. For the 40-120 micron region, the program is developing a 32x32 filled detector array. Previous work has demonstrated the required performance with a Z-Plane array architecture; we are now upgrading construction facilities and techniques to increase yields and reliability. We have completed the initial tradeoff analysis for the interconnects between the detectors and and readouts. We found satisfactory performance for both Flex-Cable and Tape Automated Bonding (TAB) devices, but analysis showed that an all-sapphire device would not meet our requirements. In addition, the effort continued to develop readouts that can operate close to the detector element temperature; success would substantially improve the manufacturability of the arrays. For the 100-200 micron range, previous work has demonstrated good performance with individual detector elements of stressed Ge:Ga; current efforts are to increase the quantum efficiency of these devices. Work continues to discover how to construct an alternate type of long wave detector, Ge:B Blocked Impurity Band devices. Following descoping of SIRTF, we are closing out the bolometer and refrigerator development. We documented the optical designs and approaches developed previously to meet the specific requirements of these detector types in terms of modulation of the signals for good photometric behavior within the constraints of a compact and self-contained cryogenic instrument. Further study was initiated for the Band 3 optical train, where we have concerns about complexity and the manufacturability of one component. Author (revised)

N93-27311*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
WORKSHOP ON HARMONIC OSCILLATORS
D. Han, ed., Y. S. Kim, ed. (Maryland Univ., College Park.), and W. W. Zachary, ed. (Howard Univ., Washington, DC.) Washington 1993 515 p Workshop held in College Park, MD, 25-28 Mar. 1992
(Contract NAS5-30376)
(NASA-CP-3197; NAS 1.55:3197; Rept-93B00036) Avail: CASI HC A22/MF A04

Proceedings of a workshop on Harmonic Oscillators held at the College Park Campus of the University of Maryland on March 25 - 28, 1992 are presented. The harmonic oscillator formalism is playing an important role in many branches of physics. This is the simplest mathematical device which can connect the basic principle of physics with what is observed in the real world. The harmonic oscillator is the bridge between pure and applied physics. For individual titles, see N93-27312 through N93-27359.

N93-27312*# Maryland Univ., College Park. Dept. of Physics and Astronomy.
QUONS, AN INTERPOLATION BETWEEN BOSE AND FERMI OSCILLATORS **c77**
O. W. Greenberg *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 5-18 Sponsored in part by NSF (For primary document see N93-27311 10-74)
Avail: CASI HC A03/MF A04

After a brief mention of Bose and Fermi oscillators and of particles which obey other types of statistics, including intermediate statistics, parastatistics, paronic statistics, anyon statistics, and infinite statistics, I discuss the statistics of 'quons' (pronounced to rhyme with muons), particles whose annihilation and creation operators obey the q-deformed commutation relation (the quon algebra or q-mutator) which interpolates between fermions and bosons. I emphasize that the operator for interaction with an external source must be an effective Bose operator in all cases. To accomplish this for parabose, parafermi and quon operators, I introduce parabose, parafermi, and quon Grassmann numbers, respectively. I also discuss interactions of non-relativistic quons, quantization of quon fields with antiparticles, calculation of vacuum matrix elements of relativistic quon fields, demonstration of the TCP theorem, cluster decomposition, and Wick's theorem for relativistic quon fields, and the failure of local commutativity of observables for relativistic quon fields. I conclude with the bound on the parameter q for electrons due to the Ramberg-Snow experiment. Author (revised)

N93-27313*# Florida Univ., Gainesville. Dept. of Physics and Mathematics.
THE UNIVERSAL PROPAGATOR **c77**
John R. Klauder *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 19-28 (For primary document see N93-27311 10-74)
Avail: CASI HC A02/MF A04

For a general Hamiltonian appropriate to a single canonical degree of freedom, a universal propagator with the property that it correctly evolves the coherent-state Hilbert space representatives for an arbitrary fiducial vector is characterized and defined. The universal propagator is explicitly constructed for the harmonic oscillator, with a result that differs from the conventional propagators for this system. Author (revised)

N93-27314*# Montreal Univ. (Quebec).
PHASE-SPACE QUANTUM MECHANICS STUDY OF TWO IDENTICAL PARTICLES IN AN EXTERNAL OSCILLATORY POTENTIAL **c77**
Luis M. Nieto (Valladolid Univ., Spain.) and Manuel Gadella (Valladolid Univ., Spain.) *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 29-34 (For primary document see N93-27311 10-74)
Avail: CASI HC A02/MF A04

This simple example is used to show how the formalism of Moyal works when it is applied to systems of identical particles. The symmetric and antisymmetric Moyal propagators are evaluated for this case; from them, the correct energy levels of energy are obtained, as well as the Wigner functions for the symmetric and antisymmetric states of the two identical particle system. Finally, the solution of the Bloch equation is straightforwardly obtained from the expressions of the Moyal propagators. Author (revised)

N93-27315*# Institute of Computational Fluid Dynamics, Tokyo (Japan).
WAVE PACKET MOTION IN HARMONIC POTENTIAL AND COMPUTER VISUALIZATION **c77**
Hideo Tsuru and Takeshi Kobayashi (Kanazawa Univ., Japan.) *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 35-40 (For primary document see N93-27311 10-74)
Avail: CASI HC A02/MF A04

Wave packet motions of a single electron in harmonic potentials or a

magnetic field are obtained analytically. The phase of the wave function which depends on both time and space is also presented explicitly. The probability density of the electron changes its width and central position periodically. These results are visualized using computer animation techniques. Author

N93-27316*# Helsinki Univ. (Finland). Dept. of Theoretical Physics.
THE SU(2) ACTION-ANGLE VARIABLES **c67**
Demosthenes Ellinas *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 41-46 (For primary document see N93-27311 10-74)
Avail: CASI HC A02/MF A04

Operator angle-action variables are studied in the frame of the SU(2) algebra, and their eigenstates and coherent states are discussed. The quantum mechanical addition of action-angle variables is shown to lead to a noncommutative Hopf algebra. The group contraction is used to make the connection with the harmonic oscillator. Author

N93-27317*# Johann-Wolfgang-Goethe-Univ., Frankfurt am Main (Germany).
ALTERNATIVE DESCRIPTIONS OF WAVE AND PARTICLE ASPECTS OF THE HARMONIC OSCILLATOR **c77**
Dieter Schuch *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 47-51 (For primary document see N93-27311 10-74)
Avail: CASI HC A01/MF A04

The dynamical properties of the wave and particle aspects of the harmonic oscillator can be studied with the help of the time-dependent Schroedinger equation (SE). Especially the time-dependence of maximum and width of Gaussian wave packet solutions allow to show the evolution and connections of those two complementary aspects. The investigation of the relations between the equations describing wave and particle aspects leads to an alternative description of the considered systems. This can be achieved by means of a Newtonian equation for a complex variable in connection with a conservation law for a nonclassical angular momentum-type quantity. With the help of this complex variable, it is also possible to develop a Hamiltonian formalism for the wave aspect contained in the SE, which allows to describe the dynamics of the position and momentum uncertainties. In this case the Hamiltonian function is equivalent to the difference between the mean value of the Hamiltonian operator and the classical Hamiltonian function. Author (revised)

N93-27318*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
SYMMETRIES OF COUPLED HARMONIC OSCILLATORS **c77**
D. Han and Y. S. Kim (Maryland Univ., College Park.) *In its* Workshop on Harmonic Oscillators 1993 p 53-66 (For primary document see N93-27311 10-74)
Avail: CASI HC A03/MF A04

It is shown that the system of two coupled harmonic oscillators possesses many interesting symmetries. It is noted that the symmetry of a single oscillator is that of the three-parameter group Sp(2). Thus two uncoupled oscillator exhibits a direct product of two Sp(2) groups, with six parameters. The coupling can be achieved through a rotation in the two-dimensional space of two oscillator coordinates. The closure of the commutation relations for the generators leads to the ten-parameter group Sp(4) which is locally isomorphic to the deSitter group O(3,2). Author

N93-27319*# Duke Univ., Durham, NC. Dept. of Physics.
THE q-HARMONIC OSCILLATORS, q-COHERENT STATES AND THE q-SYMPLECTON **c77**
L. C. Biedenharn, M. A. Lohe (Northern Territory Univ., Casuarina, Australia.), and Masao Nomura (Tokyo Univ., Japan.) *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 69-83 (For primary document see N93-27311 10-74)
(Grant NSF PHY-90-08007)
Avail: CASI HC A03/MF A04

The recently introduced notion of a quantum group is discussed conceptually and then related to deformed harmonic oscillators ('q-harmonic oscillators'). Two developments in applying q-harmonic oscillators are reviewed: q-coherent states and the q-symplecton. Author

N93-27320*# Open Univ., Milton (England).
WHICH Q-ANALOGUE OF THE SQUEEZED OSCILLATOR? **c77**
Allan I. Solomon *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 85-92 (For primary document see N93-27311 10-74)
Avail: CASI HC A02/MF A04

The noise (variance squared) of a component of the electromagnetic field - considered as a quantum oscillator - in the vacuum is equal to one half, in appropriate units (taking Planck's constant and the mass and frequency of the oscillator all equal to 1). A practical definition of a squeezed state is one for which the noise is less than the vacuum value - and the amount of squeezing is determined by the appropriate ratio. Thus the usual coherent (Glauber) states are not squeezed, as they produce the same variance as the vacuum. However, it is not difficult to define states analogous to coherent states which do have this noise-reducing effect. In fact, they are coherent states in the more general group sense but with respect to groups other than the Heisenberg-Weyl Group which defines the Glauber states. The original, conventional squeezed state in quantum optics is that associated with the group SU(1,1). Just as the annihilation operator a of a single photon mode (and its hermitian conjugate a, the creation operator) generates the Heisenberg Weyl algebra, so the pair-photon operator a(sup 2) and its conjugate generates the algebra of the group SU(1,1). Another viewpoint, more productive from the calculational stance, is to note that the automorphism group of the Heisenberg-Weyl algebra is SU(1,1). Needless to say, each of these viewpoints generalizes differently to the quantum group context. Both are discussed. The following topics are addressed: conventional coherent and squeezed states; eigenstate definitions; exponential definitions; algebra (group) definitions; automorphism group definition; example: signal-to-noise ratio; q-coherent and q-squeezed states; M and P q-bosons; eigenstate definitions; exponential definitions; algebra (q-group) definitions; and automorphism q-group definition. Author (revised)

N93-27321*# Montreal Univ. (Quebec). Lab. of Nuclear Physics.
DEFORMATION OF SUPERSYMMETRIC AND CONFORMAL QUANTUM MECHANICS THROUGH AFFINE TRANSFORMATIONS **c77**
Vyacheslav Spiridonov *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 93-108 (For primary document see N93-27311 10-74)
Avail: CASI HC A03/MF A04

Affine transformations (dilatations and translations) are used to define a deformation of one-dimensional N = 2 supersymmetric quantum mechanics. Resulting physical systems do not have conserved charges and degeneracies in the spectra. Instead, superpartner Hamiltonians are q-isospectral, i.e. the spectrum of one can be obtained from another (with possible exception of the lowest level) by q(sup 2)-factor scaling. This construction allows easily to rederive a special self-similar potential found by Shabat and to show that for the latter a q-deformed harmonic oscillator algebra of Biedenharn and Macfarlane serves as the spectrum generating algebra. A general class of potentials related to the quantum conformal algebra su(sub q)(1,1) is described. Further possibilities for q-deformation of known solvable potentials are outlined. Author (revised)

N93-27322*# Massachusetts Inst. of Tech., Cambridge. Dept. of Electrical Engineering and Computer Science.
PHASE OF THE QUANTUM HARMONIC OSCILLATOR WITH APPLICATIONS TO OPTICAL POLARIZATION
Scott R. Shepard *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 109-114 (For primary document see N93-27311 10-74)
Avail: CASI HC A02/MF A04

The phase of the quantum harmonic oscillator, the temporal distribution of a particle in a square-well potential, and a quantum theory of angles are derived from a general theory of complementarity. Schwinger's harmonic oscillator model of angular momenta is modified for the case of photons. Angular distributions for systems of identical and distinguishable particles are discussed. Unitary and antiunitary time reversal operators are then presented and applied to optical polarization states in birefringent media. Author (revised)

N93-27323*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
CONDITION FOR EQUIVALENCE OF q-DEFORMED AND ANHARMONIC OSCILLATORS **c77**
M. Artoni, Jun Zang (City Coll. of the City Univ. of New York, NY.), and Joseph L. Birman (City Coll. of the City Univ. of New York, NY.) *In its* Workshop on Harmonic Oscillators 1993 p 115-119 (For primary document see N93-27311 10-74)
Avail: CASI HC A01/MF A04

The equivalence between the q-deformed harmonic oscillator and a specific anharmonic oscillator model, by which some new insight into the problem of the physical meaning of the parameter q can be attained, are discussed. Author (revised)

N93-27324*# State Univ. of New York, Binghamton. Dept. of Physics.
NOVEL PROPERTIES OF THE q-ANALOGUE QUANTIZED RADIATION FIELD **c77**
Charles A. Nelson *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 121-126 (For primary document see N93-27311 10-74)
(Contract DE-FG02-86ER-40291)
Avail: CASI HC A02/MF A04

The 'classical limit' of the q-analog quantized radiation field is studied paralleling conventional quantum optics analyses. The q-generalizations of the phase operator of Susskind and Glogower and that of Pegg and Barnett are constructed. Both generalizations and their associated number-phase uncertainty relations are manifestly q-independent in the n greater than g number basis. However, in the q-coherent state z greater than q basis, the variance of the generic electric field, (delta(E))(sup 2) is found to be increased by a factor lambda(z) where lambda(z) greater than 1 if q not equal to 1. At large amplitudes, the amplitude itself would be quantized if the available resolution of unity for the q-analog coherent states is accepted in the formulation. These consequences are remarkable versus the conventional q = 1 limit. Author (revised)

N93-27325*# Academy of Sciences (USSR), Moscow. Physics Inst.
DISTRIBUTION OF PHOTONS IN SQUEEZED POLYMODE LIGHT
V. I. Manko *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 129-140 (For primary document see N93-27311 10-74)
Avail: CASI HC A03/MF A04

The distribution functions of photons in squeezed and correlated light for one-mode and multimode cases are obtained based on the method of integrals of motion. Correlation coefficient and squeezing parameter are calculated. The possibility to generate squeezed light using nonstationary Casimir effect is discussed. Quantum parametric Josephson junction is proposed as quantum vacuum generator of electrical vibrations. Author

N93-27326*# Indian Inst. of Tech., New Delhi. Dept. of Physics.
TWO PHOTON ANNIHILATION OPERATORS AND SQUEEZED VACUUM
Anil K. Roy, C. L. Mehta, and G. M. Saxena (National Physical Lab., New Delhi, India.) *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 141-147 (For primary document see N93-27311 10-74)
Avail: CASI HC A02/MF A04

Inverses of the harmonic oscillator creation and annihilation operators by their actions on the number states are introduced. Three of the two photon annihilation operators, viz., a(sup +/-1)a, aa(sup +/-1), and a(sup 2), have normalizable right eigenstates with nonvanishing eigenvalues. The eigenvalue equation of these operators are discussed and their normalized eigenstates are obtained. The Fock state representation in each case separates into two sets of states, one involving only the even number states while the other involving only the odd number states. It is shown that the even set of eigenstates of the operator a(sup +/-1)a is the customary squeezed vacuum S(sigma) O greater than. Author (revised)

N93-27327*# California Univ., Los Angeles. Dept. of Physics.
BOUNDARY CONDITIONS IN TUNNELING VIA QUANTUM HYDRODYNAMICS **c77**
Antonio B. Nassar (Harvard-Westlake School, North Hollywood, CA.) *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 149-154 (For primary document see N93-27311 10-74)
Avail: CASI HC A02/MF A04

Via the hydrodynamical formulation of quantum mechanics, an approach to the problem of tunneling through sharp-edged potential barriers is developed. Above all, it is shown how more general boundary conditions follow from the continuity of mass, momentum, and energy.
Author (revised)

N93-27328*# Calspan Corp., Arnold AFS, TN. AEDC Div.
USING HARMONIC OSCILLATORS TO DETERMINE THE SPOT SIZE OF HERMITE-GAUSSIAN LASER BEAMS **c36**
Sidney L. Steely *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 155-170 (For primary document see N93-27311 10-74)
Avail: CASI HC A03/MF A04

The similarity of the functional forms of quantum mechanical harmonic oscillators and the modes of Hermite-Gaussian laser beams is illustrated. This functional similarity provides a direct correlation to investigate the spot size of large-order mode Hermite-Gaussian laser beams. The classical limits of a corresponding two-dimensional harmonic oscillator provide a definition of the spot size of Hermite-Gaussian laser beams. The classical limits of the harmonic oscillator provide integration limits for the photon probability densities of the laser beam modes to determine the fraction of photons detected therein. Mathematica is used to integrate the probability densities for large-order beam modes and to illustrate the functional similarities. The probabilities of detecting photons within the classical limits of Hermite-Gaussian laser beams asymptotically approach unity in the limit of large-order modes, in agreement with the Correspondence Principle. The classical limits for large-order modes include all of the nodes for Hermite Gaussian laser beams; Sturm's theorem provides a direct proof.
Author (revised)

N93-27329*# Academy of Sciences (USSR), Moscow.
SQUEEZED STATES OF DAMPED OSCILLATOR CHAIN **c77**
O. V. Manko *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 171-177 (For primary document see N93-27311 10-74)
Avail: CASI HC A02/MF A04

The Caldirola-Kanai model of one-dimensional damped oscillator is extended to the chain of coupled parametric oscillators with damping. The correlated and squeezed states for the chain of coupled parametric oscillators with damping are constructed. Based on the concept of the integrals of motion, it is demonstrated how squeezing phenomenon arises due to parametric excitation. Author (revised)

N93-27330*# Ferrara Univ. (Italy). Dept. of Physics.
THE UNCERTAINTY PRINCIPLE IN RESONANT GRAVITATIONAL WAVE ANTENNAE AND QUANTUM NON-DEMOLITION MEASUREMENT SCHEMES **c77**
Pierluigi Fortini, Roberto Onofrio (Padua Univ., Italy.), and Alessandro Rioli (Bologna Univ., Italy.) *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 179-194 (For primary document see N93-27311 10-74)
Avail: CASI HC A03/MF A04

A review on the current efforts to approach and to surpass the fundamental limit in the sensitivity of the Weber type gravitational wave antennae is reported. Applications of quantum non-demolition techniques to the concrete example of an antenna resonant with the transducer are discussed in detail. Analogies and differences from the framework of the squeezed states in quantum optics are discussed. Author (revised)

N93-27331*# Universidad Nacional Autonoma de Mexico, Cuernavaca. Inst. of Investigations and Mathematic Applications and Systems.
HARMONIC OSCILLATOR STATES IN ABERRATION OPTICS
Kurt Bernardo Wolf *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 195-215 (For primary document see N93-27311 10-74)
Avail: CASI HC A03/MF A04

The states of the three-dimensional quantum harmonic oscillator classify optical aberrations of axis-symmetric systems due to the isomorphism between the two mathematical structures. Cartesian quanta and angular

momentum classifications have their corresponding aberration classifications. The operation of concatenation of optical elements introduces a new operation between harmonic oscillator states. Author

N93-27332*# Iowa Univ., Iowa City. Dept. of Physics and Astronomy.
POINT FORM RELATIVISTIC QUANTUM MECHANICS AND RELATIVISTIC SU(6) **c77**
W. H. Klink *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 219-233 (For primary document see N93-27311 10-74)
Avail: CASI HC A03/MF A04

The point form is used as a framework for formulating a relativistic quantum mechanics, with the mass operator carrying the interactions of underlying constituents. A symplectic Lie algebra of mass operators is introduced from which a relativistic harmonic oscillator mass operator is formed. Mass splittings within the degenerate harmonic oscillator levels arise from relativistically invariant spin-spin, spin-orbit, and tensor mass operators. Internal flavor (and color) symmetries are introduced which make it possible to formulate a relativistic SU(6) model of baryons (and mesons). Careful attention is paid to the permutation symmetry properties of the hadronic wave functions, which are written as polynomials in Bargmann spaces. Author

N93-27333*# Montreal Univ. (Quebec). Center of Research and Mathematics.
PHASE SPACE LOCALIZATION FOR ANTI-DE SITTER QUANTUM MECHANICS AND ITS ZERO CURVATURE LIMIT **c77**
Amine M. ElGradechi (Concordia Univ., Montreal, Quebec.) *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 235-239 (For primary document see N93-27311 10-74)
Avail: CASI HC A01/MF A04

Using techniques of geometric quantization and SO(sub 0)(3,2)-coherent states, a notion of optimal localization on phase space is defined for the quantum theory of a massive and spinning particle in anti-de Sitter space time. It is shown that this notion disappears in the zero curvature limit, providing one with a concrete example of the regularizing character of the constant (nonzero) curvature of the anti-de Sitter space time. As a byproduct a geometric characterization of masslessness is obtained. Author (revised)

N93-27334*# Howard Univ., Washington, DC. Dept. of Physics.
PROPER-TIME RELATIVISTIC DYNAMICS **c77**
Tepper L. Gill, W. W. Zachary, and James Lindesay *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 241-253 (For primary document see N93-27311 10-74)
Avail: CASI HC A03/MF A04

Proper-time relativistic single-particle classical Hamiltonian mechanics is formulated using a transformation from observer time to system proper time which is a canonical contact transformation on extended phase space. It is shown that interaction induces a change in the symmetry structure of the system which can be analyzed in terms of a Lie-isotopic deformation of the algebra of observables. Author

N93-27335*# Maryland Univ., College Park. Dept. of Physics.
REMARKS ABOUT MASSIVE AND MASSLESS PARTICLES IN SUPERSYMMETRY **c72**
S. V. Ketov and Y.-S. Kim *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 255-260 (For primary document see N93-27311 10-74)
Avail: CASI HC A02/MF A04

The internal space-time symmetry and simple supersymmetry of relativistic particles are briefly discussed in terms of the little group of the Poincare group. The little group generators in a finite-dimensional matrix representation of the N = 1 super-Poincare algebra are explicitly constructed. The supergeometry of a massive case continuously becomes that of a massless case in the infinite-momentum limit. The origin of the gage transformations associated with the massless supermultiplets becomes transparent in that limit. Author (revised)

N93-27336*# Liege Univ. (Belgium). Theoretical and Mathematical Physics.
ON HARMONIC OSCILLATORS AND THEIR KEMMER RELATIVISTIC FORMS **c77**
Nathalie Debergh and Jules Beckers *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 261-265 (For primary document see N93-27311 10-74)
Avail: CASI HC A01/MF A04

It is shown that Dirac (Kemmer) equations are intimately connected with (para)supercharges coming from (para)supersymmetric quantum mechanics, a nonrelativistic theory. The dimensions of the irreducible representations of Clifford (Kemmer) algebras play a fundamental role in such an analysis. These considerations are illustrated through oscillator like interactions, leading to (para)relativistic oscillators. Author (revised)

N93-27337*# Universidad Nacional Autonoma de Mexico, Cuernavaca. Inst. de Ciencias Nucleares.
THE ALGEBRA OF SUPERTRACES FOR 2+1 SUPER DE SITTER GRAVITY **c77**
L. F. Urrutia, H. Waelbroeck, and F. Zertuche *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 267-272 Sponsored in part by DGAPA and ICTP (For primary document see N93-27311 10-74)
Avail: CASI HC A02/MF A04

The algebra of the observables for 2+1 super de Sitter gravity, for one genus of the spatial surface is calculated. The algebra turns out to be an infinite Lie algebra subject to non-linear constraints. The constraints are solved explicitly in terms of five independent complex supertraces. These variables are the true degrees of freedom of the system and their quantized algebra generates a new structure which is referred to as a 'central extension' of the quantum algebra SU(2)q. Author (revised)

N93-27338*# Consejo Superior de Investigaciones Cientificas, Madrid (Spain). Inst. de Optica.
QUANTUM WORMHOLES AND HARMONIC OSCILLATORS **c77**
Luis J. Garay *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 273-279 (For primary document see N93-27311 10-74)
Avail: CASI HC A02/MF A04

The quantum state of a wormhole can be represented by a path integral over all asymptotically Euclidean four-geometries and all matter fields which have prescribed values, the arguments of the wave function, on a three-surface which divides the space time manifold into two disconnected parts. Minisuperspace models which consist of a homogeneous massless scalar field coupled to a Friedmann-Robertson-Walker space time are considered. Once the path integral over the lapse function is performed, the requirement that the space time be asymptotically Euclidean can be accomplished by fixing the asymptotic gravitational momentum in the remaining path integral. It is argued that there does not exist any wave function which corresponds to asymptotic field configurations such that the effective gravitational constant is negative in the asymptotic region. Then, the wormhole wave functions can be written as linear combinations of harmonic oscillator wave functions. Author

N93-27339*# Harvard Univ., Cambridge, MA. Lab. of Physics.
ON INDUCING FINITE DIMENSIONAL PHYSICAL FIELD REPRESENTATIONS FOR MASSLESS PARTICLES IN EVEN DIMENSIONS **c77**
Vineer Bhansali *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 281-287 (For primary document see N93-27311 10-74)
Avail: CASI HC A02/MF A04

Assuming trivial action of Euclidean translations, the method of induced representations is used to derive a correspondence between massless field representations transforming under the full generalized even dimensional Lorentz group, and highest weight states of the relevant little group. This gives a connection between 'helicity' and 'chirality' in all dimensions. Restrictions on 'gauge independent' representations for physical particles that this induction imposes are also stated. Author (revised)

N93-27340*# General Electric Co., Moorestown, NJ.
NONLINEAR MODES OF THE TENSOR DIRAC EQUATION AND CPT VIOLATION **c77**
Frank J. Reifler and Randall D. Morris *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 289-294 (For primary document see N93-27311 10-74)
Avail: CASI HC A02/MF A04

Recently, it has been shown that Dirac's bispinor equation can be expressed, in an equivalent tensor form, as a constrained Yang-Mills equation in the limit of an infinitely large coupling constant. It was also shown that the free tensor Dirac equation is a completely integrable Hamiltonian system with Lie algebra type Poisson brackets, from which Fermi quantization can be derived directly without using bispinors. The Yang-Mills equation for a finite coupling constant is investigated. It is shown that the nonlinear Yang-Mills equation has exact plane wave solutions in one-to-one correspondence with the plane wave solutions of Dirac's bispinor equation. The theory of nonlinear dispersive waves is applied to establish the existence of wave packets. The CPT violation of these nonlinear wave packets, which could lead to new observable effects consistent with current experimental bounds, is investigated. Author (revised)

N93-27341*# Institute of Nuclear Physics, Krakow (Poland).
GALILEAN COVARIANT HARMONIC OSCILLATOR **c77**
Andrzej Horzela and Edward Kapuscik (Georgia Univ., Athens.) *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 295-305 Sponsored in part by the Polish State Committee for Scientific Research (For primary document see N93-27311 10-74)
Avail: CASI HC A03/MF A04

A Galilean covariant approach to classical mechanics of a single particle is described. Within the proposed formalism, all non-covariant force laws defining acting forces which become to be defined covariantly by some differential equations are rejected. Such an approach leads out of the standard classical mechanics and gives an example of non-Newtonian mechanics. It is shown that the exactly solvable linear system of differential equations defining forces contains the Galilean covariant description of harmonic oscillator as its particular case. Additionally, it is demonstrated that in Galilean covariant classical mechanics the validity of the second Newton law of dynamics implies the Hooke law and vice versa. It is shown that the kinetic and total energies transform differently with respect to the Galilean transformations. Author (revised)

N93-27342*# Missouri Univ., Columbia. Dept. of Physics and Astronomy.
DOUBLE SIMPLE-HARMONIC-OSCILLATOR FORMULATION OF THE THERMAL EQUILIBRIUM OF A FLUID INTERACTING WITH A COHERENT SOURCE OF PHONONS **c77**
B. DeFacio, Alan VanNevel, and O. Brander (Chalmers Univ. of Technology, Goeteborg, Sweden.) *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 309-322 (For primary document see N93-27311 10-74)
(Grants AF-AFOSR-307-90; AF-AFOSR-203-91)
Avail: CASI HC A03/MF A04

A formulation is given for a collection of phonons (sound) in a fluid at a non-zero temperature which uses the simple harmonic oscillator twice; one to give a stochastic thermal 'noise' process and the other which generates a coherent Glauber state of phonons. Simple thermodynamic observables are calculated and the acoustic two point function, 'contrast' is presented. The role of 'coherence' in an equilibrium system is clarified by these results and the simple harmonic oscillator is a key structure in both the formulation and the calculations. Author (revised)

N93-27343*# Leipzig Univ. (German D.R.). Dept. of Physics.
WIGNER EXPANSIONS FOR PARTITION FUNCTIONS OF NONRELATIVISTIC AND RELATIVISTIC OSCILLATOR SYSTEMS **c77**
Christian Zylka and Guenter Vojta *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 323-336 (For primary document see N93-27311 10-74)
Avail: CASI HC A03/MF A04

The equilibrium quantum statistics of various anharmonic oscillator systems including relativistic systems is considered within the Wigner phase space formalism. For this purpose the Wigner series expansion for the partition function is generalized to include relativistic corrections. The new series for partition functions and all thermodynamic potentials yield quantum corrections in terms of powers of h(sup 2) and relativistic corrections given by Kelvin functions (modified Hankel functions) K(sub nu)(mc(sup 2)/kT). As applications, the symmetric Toda oscillator, isotonic and singular anharmonic oscillators, and hindered rotators, i.e. oscillators with cosine potential, are addressed. Author (revised)

N93-27344*# California Univ., Berkeley. Lawrence Berkeley Lab. Dept. of Physics.
DECOHERENCE OF MULTIMODE THERMAL SQUEEZED COHERENT STATES **c77**
Leehwa Yeh *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 337-352 (For primary document see N93-27311 10-74)
(Contract DE-AC03-76SF-00098; NSF PHY-90-21139)
Avail: CASI HC A03/MF A04

It is well known that any multimode positive definite quadratic Hamiltonian can be transformed into a Hamiltonian of uncoupled harmonic oscillators. Based on this theorem, the multimode thermal squeezed coherent states are constructed in terms of density operators. Decoherence of multimode thermal squeezed coherent states is investigated via the characteristic function and it is shown that the decohered (reduced) states are still thermal squeezed coherent states in general. Author

N93-27345*# Food and Drug Administration, Bethesda, MD. Biophysics Lab.
QUANTUM HARMONIC OSCILLATOR IN A THERMAL BATH **c77**
Yuhong Zhang *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 353-363 (For primary document see N93-27311 10-74)
(Grant NSF PHY-87-17155)
Avail: CASI HC A03/MF A04

The influence functional path-integral treatment of quantum Brownian motion is briefly reviewed. A newly derived exact master equation of a quantum harmonic oscillator coupled to a general environment at arbitrary temperature is discussed. It is applied to the problem of loss of quantum coherence. Author (revised)

N93-27346*# California Univ., Berkeley. Dept. of Chemistry.
A STUDY OF ELECTRON TRANSFER USING A THREE-LEVEL SYSTEM COUPLED TO AN OHMIC BATH **c77**
Masako Takasu (Kanazawa Univ., Japan.) and David Chandler *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 365-370 Sponsored by NSF (For primary document see N93-27311 10-74)
Avail: CASI HC A02/MF A04

Electron transfer is studied using a multi-level system coupled to a bosonic bath. Two body correlation functions are obtained using both exact enumeration of spin paths and Monte Carlo simulation. It was found that the phase boundary for the coherent-incoherent transition lies at a smaller friction in the asymmetric two-level model than in the symmetric two-level model. A similar coherent-incoherent transition is observed for three-level system. Author

N93-27347*# Universidad Nacional Autonoma de Mexico, Cuernavaca. Inst. de Ciencias Nucleares.
SYMMETRY ALGEBRA OF A GENERALIZED ANISOTROPIC HARMONIC OSCILLATOR **c64**
O. Castanos and R. Lopez-Pena *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 373-378 Sponsored in part by DGAPA (For primary document see N93-27311 10-74)
Avail: CASI HC A02/MF A04

It is shown that the symmetry Lie algebra of a quantum system with accidental degeneracy can be obtained by means of the Noether's theorem. The procedure is illustrated by considering a generalized anisotropic two dimensional harmonic oscillator, which can have an infinite set of states with the same energy characterized by an u(1,1) Lie algebra. Author

N93-27348*# Naples Univ. (Italy). Dept. di Scienze Fisiche.
FERMION REALIZATION OF EXCEPTIONAL LIE ALGEBRAS FROM MAXIMAL UNITARY SUBALGEBRAS **c64**
A. Sciarrino *In* NASA. Goddard Space Flight Center, Workshop on

Harmonic Oscillators 1993 p 379-383 (For primary document see N93-27311 10-74)
Avail: CASI HC A01/MF A04

From the decomposition of the exceptional Lie algebras (ELA's) under a maximal unitary subalgebra a realization of the ELA's is obtained in terms of fermionic oscillators. Author (revised)

N93-27349*# Georgia Univ., Athens. Dept. of Physics and Astronomy.
QUANTIZED DISCRETE SPACE OSCILLATORS **c77**
C. A. Uzes and Edward Kapuscik (Institute of Nuclear Physics, Krakow, Poland.) *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 385-396 (For primary document see N93-27311 10-74)
Avail: CASI HC A03/MF A04

A quasi-canonical sequence of finite dimensional quantizations was found which has canonical quantization as its limit. In order to demonstrate its practical utility and its numerical convergence, this formalism is applied to the eigenvalue and 'eigenfunction' problem of several harmonic and anharmonic oscillators. Author (revised)

N93-27350*# Montreal Univ. (Quebec). Center of Researchers and Mathematics.
ORBIT-ORBIT BRANCHING RULES **c77**
F. Gingras, J. Patera, and R. T. Sharp (McGill Univ., Montreal, Quebec.) *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 397-402 Sponsored in part by the Natural Science and Engineering Research Council of Canada and by the Ministere de l'Education de Quebec (For primary document see N93-27311 10-74)
Avail: CASI HC A02/MF A04

It is shown how the derivation of group-subgroup (IR to IR) branching rules is facilitated by the use of the much simpler (Weyl) orbit-orbit branching rules. Author (revised)

N93-27351*# Universidad Nacional Autonoma de Mexico, Cuernavaca. Inst. de Fisica.
MASS SPECTRA OF THE PARTICLE-ANTIPARTICLE SYSTEM WITH A DIRAC OSCILLATOR INTERACTION **c77**
M. Moshinsky and G. Loyola *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 405-427 Sponsored by the Sistema Nacional de Investigadores, Mexico (For primary document see N93-27311 10-74)
Avail: CASI HC A03/MF A04

The present view about the structure of mesons is that they are a quark-antiquark system. The mass spectrum corresponding to this system should, in principle, be given by chromodynamics, but this turns out to be a complex affair. Thus it is of some interest to consider relativistic systems of particle-antiparticle, with a simple type of interaction, which could give some insight on the spectra we can expect for mesons. This analysis is carried out when the interaction is of the Dirac oscillator type. It is shown that the Dirac equation of the antiparticle can be obtained from that of the particle by just changing the frequency omega into -omega. Following a procedure suggested by Barut, the equation for the particle-antiparticle system is derived and it is solved by a perturbation procedure. Thus, explicit expressions for the square of the mass spectra are obtained and its implications in the meson case is discussed. Author (revised)

N93-27352*# Yale Univ., New Haven, CT. Center for Theoretical Physics.
FROM HARMONIC TO ANHARMONIC OSCILLATORS **c77**
F. Iachello *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 429-442 (For primary document see N93-27311 10-74)
(Contract DE-FG02-91ER-40608)
Avail: CASI HC A03/MF A04

The algebraic approach to quantum mechanics is briefly reviewed. The role of oscillator realizations is discussed. Applications to vibrations of complex molecules are presented. Author

N93-27353*# Indiana Univ., Bloomington. Dept. of Physics.
ATOMIC SUPERSYMMETRY **c77**
V. Alan Kostelecky *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 443-451 (For primary document see N93-27311 10-74)
(Contracts DE-AC02-84ER-40125; DE-FG02-91ER-40661)
Avail: CASI HC A02/MF A04

Atomic supersymmetry is a quantum-mechanical supersymmetry connecting the properties of different atoms and ions. A short description of some established results in the subject are provided and a few recent developments are discussed including the extension to parabolic coordinates and the calculation of Stark maps using supersymmetry-based models. Author (revised)

N93-27354*# Toronto Univ. (Ontario). Dept. of Physics.
THE HARMONIC OSCILLATOR AND NUCLEAR PHYSICS **c77**
D. J. Rowe *In* NASA, Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 453-468 (For primary document see N93-27311 10-74)
Avail: CASI HC A03/MF A04

The three-dimensional harmonic oscillator plays a central role in nuclear physics. It provides the underlying structure of the independent-particle shell model and gives rise to the dynamical group structures on which models of nuclear collective motion are based. It is shown that the three-dimensional harmonic oscillator features a rich variety of coherent states, including vibrations of the monopole, dipole, and quadrupole types, and rotations of the rigid flow, vortex flow, and irrotational flow types. Nuclear collective states exhibit all of these flows. It is also shown that the coherent state representations, which have their origins in applications to the dynamical groups of the simple harmonic oscillator, can be extended to vector coherent state representations with a much wider range of applicability. As a result, coherent state theory and vector coherent state theory become powerful tools in the application of algebraic methods in physics. Author (revised)

N93-27355*# Pennsylvania State Univ. at Fayette, Uniontown. Dept. of Physics.
ON THE SPRING AND MASS OF THE DIRAC OSCILLATOR **c77**
James P. Crawford *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 469-474 (For primary document see N93-27311 10-74)
Avail: CASI HC A02/MF A04

The Dirac oscillator is a relativistic generalization of the quantum harmonic oscillator. In particular, the square of the Hamiltonian for the Dirac oscillator yields the Klein-Gordon equation with a potential of the form: (ar(sub 2) + b(L x S)), where a and b are constants. To obtain the Dirac oscillator, a 'minimal substitution' is made in the Dirac equation, where the ordinary derivative is replaced with a covariant derivative. However, an unusual feature of the covariant derivative in this case is that the potential is a non-trivial element of the Clifford algebra. A theory which naturally gives rise to gage potentials which are non-trivial elements of the Clifford algebra is that based on local automorphism invariance. An exact solution of the automorphism gage field equations which reproduces both the potential term and the mass term of the Dirac oscillator is presented. Author (revised)

N93-27356*# Institute of Nuclear Physics, Krakow (Poland).
CLASSICAL CONFINED PARTICLES **c77**
Andrzej Horzela and Edward Kapuscik (Georgia Univ., Athens.) *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 475-482 Sponsored in part by the Polish State Committee for Scientific Research (For primary document see N93-27311 10-74)
Avail: CASI HC A02/MF A04

An alternative picture of classical many body mechanics is proposed. In this picture particles possess individual kinematics but are deprived from individual dynamics. Dynamics exists only for the many particle system as a whole. The theory is complete and allows to determine the trajectories of each particle. It is proposed to use our picture as a classical prototype for a realistic theory of confined particles. Author (revised)

N93-27357*# Stanford Univ., CA. Linear Accelerator Center.
SECOND QUANTIZATION IN BIT-STRING PHYSICS **c77**
H. Pierre Noyes *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 483-493 (For primary document see

N93-27311 10-74)
(Contract DE-AC03-76SF-00515)
Avail: CASI HC A03/MF A04

Using a new fundamental theory based on bit-strings, a finite and discrete version of the solutions of the free one particle Dirac equation as segmented trajectories with steps of length h/mc along the forward and backward light cones executed at velocity +/- c are derived. Interpreting the statistical fluctuations which cause the bends in these segmented trajectories as emission and absorption of radiation, these solutions are analogous to a fermion propagator in a second quantized theory. This allows us to interpret the mass parameter in the step length as the physical mass of the free particle. The radiation in interaction with it has the usual harmonic oscillator structure of a second quantized theory. How these free particle masses can be generated gravitationally using the combinatorial hierarchy sequence (3,10,137,2(sup 127) + 136), and some of the predictive consequences are sketched. Author (revised)

N93-27358*# New York Univ., New York. Dept. of Radiology.
COVARIANT HARMONIC OSCILLATORS: 1973 REVISITED **c77**
M. E. Noz *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 495-510 (For primary document see N93-27311 10-74)
Avail: CASI HC A03/MF A04

Using the relativistic harmonic oscillator, a physical basis is given to the phenomenological wave function of Yukawa which is covariant and normalizable. It is shown that this wave function can be interpreted in terms of the unitary irreducible representations of the Poincare group. The transformation properties of these covariant wave functions are also demonstrated. Author (revised)

N93-27359*# IIT Research Inst., Annapolis, MD.
CALCULATION OF THE NUCLEON STRUCTURE FUNCTION FROM THE NUCLEON WAVE FUNCTION **c77**
Paul E. Hussar *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 511-523 (For primary document see N93-27311 10-74)
Avail: CASI HC A03/MF A04

Harmonic oscillator wave functions have played an historically important role in our understanding of the structure of the nucleon, most notably by providing insight into the mass spectra of the low-lying states. High energy scattering experiments are known to give us a picture of the nucleon wave function at high-momentum transfer and in a frame in which the nucleon is traveling fast. A simple model that crosses the twin bridges of momentum scale and Lorentz frame that separate the pictures of the nucleon wave function provided by the deep inelastic scattering data and by the oscillator model is presented. Author

N93-27524# Brookhaven National Lab., Upton, NY.
ANALOG SIGNAL ISOLATION TECHNIQUES
E. R. Beadle 1992 7 p Presented at the 1992 Accelerator Instrumentation Workshop, Berkeley, CA, 27-30 Oct. 1992
(Contract DE-AC02-76CH-00016)
(DE93-008059; BNL-48126; CONF-9210246-15) Avail: CASI HC A02/MF A01

This paper discusses several techniques for isolating analog signals in an accelerator environment. The techniques presented here encompass isolation amplifiers, voltage-to-frequency converters (VIFCs), transformers, optocouplers, discrete fiber optics, and commercial fiber optic links. Included within the presentation of each method are the design issues that must be considered when selecting the isolation method for a specific application. DOE

N93-27695# New Mexico Univ., Albuquerque. Center for High Technology Materials.
OPTOELECTRONIC MATERIALS CENTER: A COLLABORATIVE PROGRAM INCLUDING UNIVERSITY OF NEW MEXICO, STANFORD UNIVERSITY AND CALIFORNIA INSTITUTE OF TECHNOLOGY Quarterly Report, 1 Jul. - 30 Sep. 1992
S. R. Brueck 11 Dec. 1992 8 p
(Contract MDA972-90-C-0046; ARPA Order 7526)
(AD-A262377) Avail: CASI HC A02/MF A01

The Optoelectronic Materials Center is a collaborative program involving the University of New Mexico, Stanford University, and the California Institute of Technology. Sandia National Laboratories and MIT Lincoln Laboratory are also involved in this program under separate contract vehicles. This program emphasizes three main areas: (1) diode-based visible sources; (2) two-dimensional optical interconnects; and (3) high-speed optoelectronics. Progress on individual tasks is discussed briefly in this report. Several tasks affect more than one of the above areas. For simplicity, the tasks are arranged by institution in an order roughly determined by the above areas. DTIC

N93-27912# Utah Univ., Salt Lake City.
WORKSHOP ON OPTICAL PROPERTIES OF MESOSCOPIC SEMICONDUCTOR STRUCTURES Final Report, 15 Jan. 1991 - 31 Dec. 1991
P. C. Taylor 28 Mar. 1993 9 p Workshop held in Snowbird, UT, 23-26 Apr. 1991
(Contract N00014-91-J-1302)
(AD-A263024) Avail: CASI HC A02/MF A01

A Workshop on Optical Properties of Mesoscopic Semiconductor Structures was held at Snowbird, UT on 23-26 April 1991. The workshop attracted approximately 85 attendees with 22 invited speakers and approximately 20 contributed speakers. The objective of the workshop was to focus on fundamental electronic and optical processes and device applications of novel semiconducting microstructures, with particular emphasis upon understanding, optimizing, and exploiting large optical nonlinearities. DTIC

N93-28111# Adtech Systems Research, Inc., Dayton, OH.
ENHANCED CHROMOPHORE POLYMERIC NLO MATERIALS Final Report, 1 Jul. - 31 Dec. 1992
Som Soni Jan. 1993 8 p
(Contract F49620-92-C-0032)
(AD-A262258; AFOSR-93-0169TR) Avail: CASI HC A02/MF A01

Nonlinear optical (NLO) materials are an important component of many prospective Air Force applications including optical signal processing (switches, modulators, and guided-wave devices), and new laser sources (optical parametric oscillators and harmonic generators). Considerable progress has been made in the synthesis of frequency doubling (second harmonic generation - SHG) NLO chromophores and of polymeric materials containing such chromophores. A number of these SHG-NLO materials show noteworthy promise in small-scale characterizations. Commercialization of any of them requires that significant quantities of the materials, of demonstrable purity and stability, be readily available on a routine basis to these researchers who determine processing conditions as well as device manufactures. DTIC

N93-28123# Optical Society of America, Washington, DC.
NONLINEAR OPTICS: MATERIALS, FUNDAMENTALS, AND APPLICATIONS. POSTDEADLINE PAPERS
21 Aug. 1992 68 p Topical meeting held in Lahaina, HI, 17-21 Aug. 1992
(Contracts N00014-92-J-1373; DE-AC03-765F-00098)
(AD-A261807) Avail: CASI HC A04/MF A01

The Nonlinear Optics: Materials, Fundamentals, and Applications conference was held on 17-21 Aug. 1992. The following topics were addressed: subpicosecond time resolved four-wave mixing spectroscopy in heteroepitaxial ZnSe thin layers; anisotropic two-photon transition in GaAs/AlGaAs multiple quantum well waveguides; two picosecond, narrow-band, tunable, optical parametric systems using BBO and LBO; second generation in an optically active liquid: experimental observation of a fourth-order optical nonlinearity due to molecular chirality; optical image recognition system implemented with a 3-D memory disk; phase-matched second-harmonic generation in waveguides of polymeric Langmuir-Blodgett films; fluence dependent dynamics observed in the resonant third-order optical response of C60 and C70 films; temporal modulation of spatial optical solitons: a variational approach; measurements of light-scattering noise during two-wave mixing in a Kerr medium; excess noise introduced by beam propagation through an atomic vapor; an approach to all-optical switching based on second-order nonlinearities; multilayer, nonlinear ARROW waveguides for surface emitted sum-frequency mixing; energy scaling of SBS phase conjugate mirrors to 4J; vector versus scalar theory for the

double phase conjugate mirror; cross-talk and error probability in counter-beam lambda-multiplexed digital holograms; and modal growth of SHG in doped silica thin film waveguides. CASI

N93-28133*# National Aeronautics and Space Administration. Pasadena Office, CA.
MOTION-SENSITIVE OPTICAL CORRELATOR Patent Application
Tsuen-Hsi Liu, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) 7 Apr. 1993 14 p
(Contract NAS7-918)
(NASA-Case-NPO-18769-1-CU; NAS 1.71:NPO-18769-1-CU;
US-Patent-Appl-SN-046331) Avail: CASI HC A03/MF A01

A new type of optical correlator is presented. The correlator performs motion detection or background clutter suppression and correlation simultaneously in a single photorefractive crystal. Additionally, the device is useful for moving target identification and tracking and for stationary clutter rejection. The correlation is of the VanderLugt type, and the motion detection or background clutter suppression is based on the erasing property of photorefractive crystals. NASA

N93-28135*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
FULL COMPLEX MODULATION USING TWO ONE-PARAMETER SPATIAL LIGHT MODULATORS Patent Application
Richard D. Juday, inventor (to NASA) 10 Nov. 1992 37 p
(NASA-Case-MSC-22255-1; NAS 1.71:MSC-22255-1;
US-Patent-Appl-SN-977302) Avail: CASI HC A03/MF A01

Full complex spatial light modulation is enabled by an optically additive combination of the actions of separate and independent spatial light modulators, even though the independent modulators can each express only a one-parameter subset of complex values called its operating curve. Similarly the operating curve of a single modulator can be shifted (biased) by optically adding a constant complex value. NASA

N93-28376# Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
NONLINEAR OPTICS IN THREE LEVEL ATOMIC SYSTEMS Final Report, Jun. 1989 - May 1992
S. Ezekiel Dec. 1992 62 p
(Contract F19628-89-K-0030)
(AD-A262793; RL-TR-92-278) Avail: CASI HC A04/MF A01

The nonlinear optical properties of three-level atomic systems in the resonance Raman configuration are investigated both theoretically and experimentally. Special emphasis is placed on the optical properties which are unique to three-level systems, and have potential device applications. In particular, microwave-phase-dependent optical absorption is demonstrated experimentally. This is of interest because of potential applications to microwave circuit phase mapping, and mm-wave to FIR beam steering and image conversion. Optical data storage with Raman excited microwave spin echoes is also demonstrated experimentally. This technique has potential for increasing storage densities in optical echo memories and may lead to near-room-temperature materials for echo storage and processing. Finally, the optical forces on three-level atoms in Raman resonant standing waves are studied to investigate the potential for using trapped neutral atoms as nonlinear optical elements. DTIC

N93-28403# Applied Research, Inc., Huntsville, AL.
ANALYSIS OF ELECTRO-OPTIC MATERIALS PROPERTIES ON GUIDED WAVE DEVICES Final Report, May - Dec. 1992
Krishna Myneni and Eric Webster 16 Dec. 1992 11 p
(Contract DAAH01-89-D-0069)
(AD-A262787; AD-E951956; ARI/92/R-048Z) Avail: CASI HC A03/MF A01

This report summarizes the support of ARI personnel to the development, test and analysis of waveguide structures which have potential use in integrated optical devices. The work objective was to support the research and development effort in the design, construction, and testing of electro-optical components for signal processing and sensor devices in missile applications at the Weapons Sciences Directorate, US Army Missile Command. DTIC

N93-28428*# National Aeronautics and Space Administration. Pasadena Office, CA.
ABERRATION CORRECTION OF UNSTABLE RESONATORS Patent Application
Robert J. Lang, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) 22 Feb. 1993 29 p
(Contract NAS7-918)
(NASA-Case-NPO-18662-1-CU; NAS 1.71:NPO-18662-1-CU;
US-Patent-Appl-SN-020813) Avail: CASI HC A03/MF A01

Construction of aspheric reflectors for unstable resonator lasers to provide an arbitrary laser mode inside the resonator to correct aberrations of an output beam by the construction of the shape of an end reflector opposite the output reflector of the resonator cavity, such as aberrations resulting from refraction of a beam exiting the solid of the resonator having an index of refraction greater than 1 or to produce an aberration in the output beam that will precisely compensate for the aberration of an optical train into which the resonator beam is coupled, is described. NASA

N93-28448*# Itek Corp., Lexington, MA. Optical Systems.
LUTE PRIMARY MIRROR STUDY Final Report
14 May 1993 100 p
(NASA Order H-19669-D)
(NASA-CR-193069; NAS 1.26:193069) Avail: CASI HC A05/MF A02

A brief study of primary mirror options for the Lunar Ultraviolet Telescope (LUTE) was conducted to evaluate the potential of either a passive or active mirror configuration to achieve 'diffraction limited' performance in the lunar surface environment, described in the LUTE telescope analyses done by the MSFC task team. Itek therefore started from the premise that any acceptable design must achieve the desired weight given in the overall LUTE weight statement, and must achieve a wave front error (WFE) of 0.03 microns rms in the environment of the LUTE analyses. Summary data describing active and passive mirror configurations which have an acceptable weight and would provide high quality wave front performance are provided. This information is in the form of presentation material used for a final briefing held at Itek on 10 May 1993. As appendix material, copies of memos and other information provided in the course of the study activity, as well as some information describing Itek-manufactured hardware, made to meet similar requirements for other programs, are included.
Author (revised)

N93-28456# Stanford Research Inst., Menlo Park, CA.
WORKSHOP ON SCIENTIFIC APPLICATIONS OF SHORT WAVELENGTH COHERENT LIGHT SOURCES
W. Spicer, J. Arthur, and H. Winick Feb. 1993 135 p Workshop held in Stanford, CA, 21 Oct. 1992
(Contract DE-AC03-76SF-00515)
(DE93-009617; SLAC-414; SLAC/SSRL-0007; CONF-9210278) Avail: CASI HC A07/MF A02

This report discusses the following topics: a 2 to 4 nm high power FEL on the SLAC linac; atomic physics with an x-ray laser; high resolution, three dimensional soft x-ray imaging; the role of x-ray induced damage in biological micro-imaging; prospects for x-ray microscopy in biology; femtosecond optical pulses; research in chemical physics surface science, and materials science, with a linear accelerator coherent light source; application of 10 GeV electron driven x-ray laser in gamma-ray laser research; non-linear optics, fluorescence, spectromicroscopy, stimulated desorption: we need LCLS' brightness and time scale; application of high intensity x-rays to materials synthesis and processing; LCLS optics: selected technological issues and scientific opportunities; possible applications of an FEL for materials studies in the 60 eV to 200 eV spectral region. DOE

N93-27889*# Massachusetts Inst. of Tech., Cambridge. Space Engineering Research Center.
INTERFEROMETER TESTBED: OVERVIEW AND HARDWARE SUMMARY
Andrew Nisbet *In its* Controlled Structures Technology Steering Committee Workshop 1992 10 p (For primary document see N93-27888 10-39)
Avail: CASI HC A02/MF A03

N93-28168*# Massachusetts Inst. of Tech., Cambridge.
OPTICAL INTERFEROMETER TESTBED

Gary H. Blackwood *In its* The 3rd Annual Controlled Structures Technology Symposium 1 Jul. 1991 26 p (For primary document see N93-28167 10-39)
Avail: CASI HC A03/MF A03

N93-28270*# Sverdrup Technology, Inc., Arnold AFS, TN. Arnold Engineering Development Center Group.
SPECTRAL INFRARED HEMISPHERICAL REFLECTANCE MEASUREMENTS FOR LDEF TRAY CLAMPS
B. K. Cromwell, S. D. Shepherd (Air Force Systems Command, Arnold AFS, TN.), C. W. Pender, and B. E. Wood (Calspan Corp., Arnold AFS, TN.) *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 1001-1014 (For primary document see N93-28254 10-99)
Avail: CASI HC A03/MF A04; 2 functional color pages

N93-28274*# TRW Electronic Systems Group, Redondo Beach, CA.
OPTICAL CHARACTERIZATION OF LDEF CONTAMINANT FILM
Brian K. Blakkolb, Lorraine E. Ryan, Howard S. Bowen (Hughes Aircraft Co., El Segundo, CA.), and Thomas J. Kosic (Hughes Aircraft Co., El Segundo, CA.) *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 1035-1040 (For primary document see N93-28254 10-99)
Avail: CASI HC A02/MF A04; 2 functional color pages

N93-28284*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
THE INTERACTION OF ATOMIC OXYGEN WITH COPPER: AN XPS, AES, XRD, OPTICAL TRANSMISSION, AND STYLUS PROFILOMETRY STUDY
Ganesh N. Raikar (Alabama Univ., Huntsville.), John C. Gregory (Alabama Univ., Huntsville.), Ligia C. Christl (Alabama Univ., Huntsville.), and Palmer N. Peters *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 1169-1186 (For primary document see N93-28254 10-99)
Avail: CASI HC A03/MF A04; 2 functional color pages

75 PLASMA PHYSICS

Includes magnetohydrodynamics and plasma fusion.

For ionospheric plasmas see *46 Geophysics*. For space plasmas see *90 Astrophysics*.

N93-26617# Texas Univ., Austin. Fusion Research Center.
PLASMA CONFINEMENT THEORY AND TRANSPORT SIMULATION
D. W. Ross Feb. 1993 6 p
(Contract DE-FG05-88ER-53266)
(DE93-009755; DOE/ER-53266/42; FRCR-428) Avail: CASI HC A02/MF A01

The objectives continue to be: (1) to advance the transport studies of tokamaks, including development and maintenance of the Magnetic Fusion Energy Database, and (2) to provide theoretical interpretation, modeling and equilibrium and stability for TEXT-Upgrade. Recent publications and reports, and conference presentations of the Fusion Research Center theory group are listed. DOE

N93-27620# Los Alamos National Lab., NM.
TIME EVOLUTION OF THE QUARK-GLUON PLASMA
F. Cooper 1993 5 p Presented at the HIPAGS Meeting, Cambridge, MA, 14-17 Jan. 1993
(Contract W-7405-eng-36)
(DE93-008703; LA-UR-93-547; CONF-930173-2) Avail: CASI HC A01/MF A01

We review progress in our understanding the production and time evolution of the quark gluon plasma starting with boost invariant initial conditions in a field theory model based on the Schwinger mechanism of particle production via tunneling. DOE

N93-28233# Lawrence Livermore National Lab., CA.
COHERENT STRUCTURES IN TOKAMAK PLASMAS WORKSHOP: PROCEEDINGS
A. E. Koniges, G. G. Craddock, and P. H. Diamond Aug. 1992 225 p Presented at the First Workshop on Coherent Structures in Tokamak Plasmas, Livermore, CA, 2-3 Jun. 1992
(Contract W-7405-eng-48)
(DE93-009558; CONF-9206263) Avail: CASI HC A10/MF A03

Coherent structures have the potential to impact a variety of theoretical and experimental aspects of tokamak plasma confinement. This includes the basic processes controlling plasma transport, propagation, and efficiency of external mechanisms such as wave heating and the accuracy of plasma diagnostics. While the role of coherent structures in fluid dynamics is better understood, this is a new topic for consideration by plasma physicists. This informal workshop arose out of the need to identify the magnitude of structures in tokamaks and in doing so, to bring together, for the first time, the surprisingly large number of plasma researchers currently involved in work relating to coherent structures. The primary purpose of the workshop, in addition to the dissemination of information, was to develop formal and informal collaborations, set the stage for future formation of a coherent structures working group or focus area under the heading of the Tokamak Transport Task Force, and to evaluate the need for future workshops on coherent structures. The workshop was concentrated in four basic areas with a keynote talk in each area as well as 10 additional presentations. The issues of discussion in each of these areas was as follows: Theory--develop a definition of structures and coherent as it applies to plasmas; Experiment--review current experiments looking for structures in tokamaks, discuss experimental procedures for finding structures, and discuss new experiments and techniques; Fluids--determine how best to utilize the resource of information available from the fluids community both on the theoretical and experimental issues pertaining to coherent structures in plasmas; and Computation--discuss computational aspects of studying coherent structures in plasmas as they relate to both experimental detection and theoretical modeling. DOE

N93-28332# Department of Energy, Pittsburgh, PA. Technology Center.
MHD CONTRACTORS' REVIEW CONFERENCE
1993 212 p Presented at the MHD Contractor's Review Meeting, Pittsburgh, PA, 2-4 Feb. 1993
(DE93-009883; CONF-930270) Avail: CASI HC A10/MF A03

The MHD Contractors' Review Conference was held at Pittsburgh, PA, February 2-4, 1993. Eleven papers were presented. Papers were related to the CDIF topping cycle, to the CFFF bottoming cycle, diagnostic techniques, heat recovery, seed recovery, design of a coal-fired MHD retrofit plant, and the design of a retrofit MHD magnet. Papers have not been entered individually in view of the rather narrow subject area. DOE

N93-28335# California Univ., San Diego, La Jolla. Dept. of Physics.
DEVELOPMENT OF A POSITRONIUM ATOM DIAGNOSTIC BEAM TO STUDY TRANSPORT IN TOKAMAKS
C. M. Surko 1992 6 p
(Contract DE-FG03-89ER-53294)
(DE93-010916; DOE/ER-53294/T1) Avail: CASI HC A02/MF A01

Anomalous transport is probably the key physics issue in magnetic confinement fusion. It severely limits our ability to create and maintain a dense, hot, fusion plasma. There is also good evidence that there is a fundamental lack of understanding in this area, namely the transport of particles and energy induced by waves and fluctuations in magnetically confined plasmas. The positronium atom beam diagnostic, if successful, can provide a qualitatively new and different way of studying transport in tokamak fusion plasmas. The use of the positron as a thermalized, electron-mass test particle will allow important new tests of current theories of plasma transport. In particular, it could provide unique insights into the potential role of magnetic fluctuations in producing anomalous transport. This is particularly significant in that, at present, there is essentially no in situ probe of these fluctuations or the transport which they produce. Some results of this study are summarized. DOE

N93-28348# General Atomic Co., San Diego, CA.
ON THE SECOND HARMONIC ELECTRON CYCLOTRON RESONANCE HEATING AND CURRENT DRIVE EXPERIMENTS ON T-10 AND D3-D
J. Lohr, C. B. Forest, Y. R. Lin-Liu, T. C. Luce, R. W. Harvey, E. A. Downs (Cornell Univ., Ithaca, NY.), and R. A. James (Lawrence Livermore National Lab., CA.) Feb. 1993 16 p Presented at the EC 8 Joint Workshop on Electron Cyclotron Emission and Electron Cyclotron Heating,

Gut Ising, Germany, 19-21 Oct. 1992
(Contracts DE-AC03-89ER-51114; W-7405-eng-48)
(DE93-008987; GA-A-21107; CONF-9210300-2) Avail: CASI HC A03/MF A01

Studies of electron cyclotron current drive at the second harmonic resonance have been performed both on the D3-D and T-10 tokamaks at injected power levels of approximately 0.5 MW. The D3-D experiment used high held launch of the extraordinary mode at an angle of 15 deg to the radial. In this experiment, with pulse lengths approximately equal to 500 msec, a loop voltage difference, compared to the value expected from the measured profiles, of approximately equal to 50 mV was ascribed to approximately 50 kA of RF-driven current. When dc electric field and trapped particle effects were considered, this was consistent with theoretical predictions. The T-10 experiments planned for the fall of 1992 will use low field launch of the extraordinary mode and an injection angle of 21 deg off-radial. In preliminary experiments with relatively poor machine conditions and pulse lengths approximately equal to 400 msec, RF current drive was not observed despite the fact that driven currents as low as 10 kA, corresponding to a loop voltage difference for co- versus counter-injection of 20 mV, could have been detected. In this paper we examine the T-10 experiments using ray tracing and transport calculations in an attempt to understand the results. The dependence of the current drive efficiency on discharge parameters, flux penetration, and non-linear effects will be discussed. The results show that the launching geometry can have a significant effect on the observation of electron cyclotron current drive using the loop voltage as a diagnostic. In addition, predictions for the next series of experiments on T-10, for which greater than 2 MW of high frequency power should be available, will be presented. DOE

N93-28349# General Atomic Co., San Diego, CA.
CONFINEMENT AND STABILITY OF VH-MODE DISCHARGES IN THE D3-D TOKAMAK
T. S. Taylor, T. H. Osborne, K. H. Burrell, T. N. Carlstrom, V. S. Chan, M. S. Chu, J. C. DeBoo, E. J. Doyle, C. M. Greenfield, and R. J. Groebner et al Oct. 1992 17 p Presented at the 14th International Conference on Plasma Physics and Controlled Nuclear Fusion Research, Wurzburg, Germany, 30 Sep. - 7 Oct. 1992
(Contracts DE-AC03-89ER-51114; DE-AC05-84OR-21400; W-7405-eng-48)
(DE93-008988; GA-A-21092; CONF-9209290-7) Avail: CASI HC A03/MF A01

A regime of very high confinement (VH-mode) has been observed in neutral beam-heated deuterium discharges in the D3-D tokamak with thermal energy confinement times up to approximately 3.6 times that predicted by the ITER-89P L-mode scaling and 2 times that predicted by ELM-free H-mode thermal confinement scalings. This high confinement has led to increased plasma performance, eta(sub D)(0)T(sub i)(0)(tau)(sub E) = 2(10)(exp 20) m(exp -3) keV sec with I(sub p) = 1.6 MA, B(sub T) = 2.1 T, and Z(sub eff) less than or equal to 2. Detailed transport analysis shows a correspondence between the large decrease in thermal diffusivity in the region 0.75 less than or equal to (rho) less than or equal to 0.9 and the development of a strong shear in the radial electric field in the same region. This suggests that stabilization of turbulence by sheared E x B flow is responsible for the improved confinement in VH-mode. A substantial fraction of the edge plasma entering the second regime of stability may also contribute to the increase in confinement. The duration of the VH-mode phase has been lengthened by feedback controlling the input power to limit plasma beta. DOE

N93-28412 Michigan Univ., Ann Arbor.
MODELLING OF PLASMASPHERIC FLOWS Ph.D. Thesis
Steven Mark Guiter 1992 165 p
Avail: Univ. Microfilms Order No. DA9308325

Flows on a plasmaspheric flux tube were modelled, using a fully interhemispheric model in which no low speed assumptions are made. The model is time-dependent and hydrodynamic; it is an adaptation, for closed dipolar field lines, of a polar wind model developed by Gombosi et al. (1985). Both one- and two-stream versions were developed. The model simultaneously solves the coupled continuity, momentum, and energy equations of a two-ion (H+ and O+) quasi neutral, currentless plasma. The coupled time-dependent partial differential equations are solved using a combined Godunov scheme/Crank-Nicolson method with dimensional splitting. The model takes into account the effects of ionization, charge exchange, recombination, collisions, heat conduction, and allows for external heat sources. The model flux tube connects external reservoirs, each at an altitude of 200 km; these reservoirs represent photochemically controlled regions of the ionosphere. The neutral species densities and the neutral temperature are found using the MSIS-86 model (Hedin, 1987). The one-stream version of this model has been used to investigate plasmaspheric refilling following density depletions on an L = 2 flux tube, which were simulated by dividing steady state ion densities by an arbitrary factor above 2500 km altitude; to study the effect of equatorially confined H+ heating on an L = 4 flux tube; to model diurnal variations on an L = 2 flux tube; and to investigate annual variations in plasmaspheric density. The two-stream version was used to study plasmaspheric refilling on an L = 4 flux tube following a density depletion; the initial H+ density profiles were chosen to be similar to those used by Rasmussen and Schunk (1988). The results from the plasmaspheric refilling studies indicate that for an initial period refilling occurs from the equator downward, between downward moving shocks. The study of equatorially confined H+ heating showed that heating rates which are consistent with observed magnitudes of warm, trapped, an isotropic plasma would not significantly affect the thermal population. The most striking result from the diurnal variations study was the large downward H+ velocity which occurs in the southern end in the early morning. The study of annual variations in plasmaspheric density showed that these are due to variations in O+ density in the upper ionosphere. The results found with the model are generally consistent with those found in earlier work; significant differences include temperature variations, as were seen in the refilling studies, and strong transients, as were found in the diurnal variations study. Dissert. Abstr.

N93-28421# Lawrence Livermore National Lab., CA.
A STUDY OF THERMAL HYDRAULIC AND KINETIC PHENOMENA IN HYLIFE-2: AN INERTIAL CONFINEMENT FUSION REACTOR Ph.D. Thesis
Xiang Ming Chen 27 Jan. 1993 266 p
(Contract W-7405-eng-48)
(DE93-008372; UCRL-ID-112698) Avail: CASI HC A12/MF A03

Researchers have studied the different aspects of commercial fusion energy for several decades. A variety of inertial confinement fusion (ICF) reactors have been proposed. Different from the magnetic confinement fusion concept, inertial confinement fusion does not need long-term confinement of the fusion fuel but achieves fusion reaction in a short microexplosion under a high density, high temperature condition. The HYLIFE-2 reactor design started in 1987 is based on the study of a previous concept called HYLIFE (High Yield Lithium Injection Fusion Energy). Similar to the old concept, the HYLIFE-2 design uses a vacuum chamber in which D-T fusion pellets are injected and ignited by high energy beams shot into the reactor through different ports. The reactor vessel is protected from explosion radiations by a liquid fall (blanket) that also breeds tritium through the (n, alpha) reaction of lithium and conveys the fusion energy to the power cycle. In addition to some geometric chances, the new design replaces liquid metal lithium with the molten salt Flibe (Li2BeF4) as the protective blanket material. The objective was to remove the possibility of fire hazard. The important thermal hydraulic issues in the design are (1) equation of state of Flibe; (2) liquid relaxation after isochoric (constant volume) heating; (3) ablation and gas dynamics; (4) interaction of the vapor and liquid; and (5) condensation of the vaporized material. The first four issues have to do with the internal relaxation after the fusion microexplosion in the chamber. Vaporized material, as well as liquid, may assert strong impulses on the chamber wall during the process of relaxing after absorbing the energy from the microexplosion. Item (5) is related to the rapid vacuum recovery between the ignitions. Some aspects of the first four issues are studied. DOE

76 SOLID-STATE PHYSICS

Includes superconductivity.

For related information, see also *33 Electronics and Electrical Engineering* and *36 Lasers and Masers.*

N93-26618# Oregon Univ., Eugene.
SURFACE AND INTERFACE ELECTRONIC STRUCTURE: THREE YEAR ACTIVITY REPORT

S. D. Kevan 1992 13 p
(Contract DE-FG06-86ER-45275)
(DE93-010209; DOE/ER-45275/T2) Avail: CASI HC A03/MF A01

The 3-year activity report covers surface structure and phonon anomalies (surface reconstruction on W(001) and Mo(001), adsorbate lateral ordering, surface Fermi contours and phonon anomalies on Pt(111) and Pd(001)), adsorbate vibrational damping, charge transfer in momentum space, surface states and resonances (relativistic effects, computations, surface resonances). DOE

N93-26639# Sandia National Labs., Albuquerque, NM.
STRAIN-RELAXED InGaAs BUFFER LAYERS GROWN BY MOLECULAR-BEAM EPITAXY FOR 1.3 (MU)m FABRY-PEROT OPTICAL MODULATORS
B. E. Hammons, I. J. Fritz, T. M. Brennan, A. J. Howard, and J. A. Olsen 1992 12 p Presented at the North American Conference on Molecular Beam Epitaxy, Ontario, 12-14 Oct. 1992
(Contract DE-AC04-76DP-00789)
(DE93-006774; SAND-92-1692C; CONF-9210296-1) Avail: CASI HC A03/MF A01

The effects of various growth temperatures on molecular-beam epitaxially (MBE) grown compositionally graded, In(0.33)Ga(0.67)As buffers and 1.33 (mu)m optoelectronic device structures were investigated. Buffer structures grown at 400 degrees C on GaAs substrates showed >99.5% lattice relaxation with minimal threading dislocation content. Multiple quantum well superlattices grown at 400 degrees C upon this buffer exhibited strong excitonic absorption at 1.33 (mu)m and good surface morphology with slight cross-hatching. A Fabry-Perot-cavity reflectance modulator grown at 400 degrees C on this buffer exhibited strong excitonic absorption and good reflectance contrast at 1.33 (mu)m. DOE

N93-26667# North Carolina State Univ., Raleigh.
BAND ELECTRONIC STRUCTURES AND CRYSTAL PACKING FORCES
1993 11 p
(Contract DE-FG05-86ER-45259)
(DE93-009763; DOE/ER-45259/16) Avail: CASI HC A03/MF A01

We investigated the electronic and structural properties of low-dimensional materials and explored the structure-property correlations governing their physical properties. Progress was made on how to interpret the scanning tunneling microscopy and atomic force microscopy images of layered materials and on how to account for charge density wave instabilities in 2-D metals. Materials studied included transition metal chalcogenides, transition metal halides, organic conducting salts, Mo bronzes, A2PdH2, fullerenes, squarate tetrahydrate polymers Fe, BEDT salts, etc. DOE

N93-27094*# Rutgers Univ., New Brunswick, NJ. Dept. of Computer Science.
RUTGER'S CAM2000 CHIP ARCHITECTURE
Donald E. Smith, J. Storrs Hall, and Keith Miyake Apr. 1993 35 p
(Grant NAG2-668)
(NASA-CR-193078; NAS 1.26:193078; LCSR-TR-196) Avail: CASI HC A03/MF A01

This report describes the architecture and instruction set of the Rutgers CAM2000 memory chip. The CAM2000 combines features of Associative Processing (AP), Content Addressable Memory (CAM), and Dynamic Random Access Memory (DRAM) in a single chip package that is not only DRAM compatible but capable of applying simple massively parallel operations to memory. This document reflects the current status of the CAM2000 architecture and is continually updated to reflect the current state of the architecture and instruction set. Author (revised)

N93-27522# Sandia National Labs., Albuquerque, NM.
INVESTIGATION OF MISFIT DISLOCATION CONFIGURATIONS IN MBE-GROWN InGaAs LAYERS ON MISALIGNED GaAs (001) SUBSTRATES
P. Werner, N. D. Zakharov, Y. Chen, Z. Liliental-Weber, J. Washburn, J. F. Klem, and J. Y. Tsao 1992 5 p Presented at the 16th Material Research Society International Symposium on the Scientific Basis for Nuclear Waste Management Fall Meeting, Boston, MA, 30 Nov. - 5 Dec. 1992
(Contracts DE-AC04-76DP-00789; DE-AC03-76SF-00098)
(DE93-007578; SAND-92-1757C; CONF-921101-96) Avail: CASI HC A01/MF A01

The configurations of misfit dislocations in In(0.2)Ga(0.8)As/GaAs(001) heterostructures grown on slightly misoriented substrates was investigated by transmission electron microscopy (TEM). Layers 6 nm, 20 nm and 40 nm thick were grown by MBE. The substrate was tilted in (1 1 0), (1 bar-1 0), (1 bar-2 0), (2 1 0) and (0 1 0) directions at angles between 0 and 10 degrees. Only in the 40 nm thick layers networks of 60 and 90 degree dislocations were formed. Misfit dislocations were found at the interface in (1 1 0) directions. In the substrate tilting range between 0 and 4 degrees the changes in dislocation density can be explained by the different character of alpha and beta dislocations. For a substrate tilting above 6 deg the different dislocation sets show an increased anisotropy. The misfit dislocations at the interface were decorated by In atoms. The influence of three-dimensional crystal growth on increasing surface roughness is discussed. DOE

N93-27580# Rome Univ. (Italy). Dipt. di Fisica.
PHASE SEPARATION AND SUPERCONDUCTIVITY IN THE U EQUALS INFINITY LIMIT OF THE EXTENDED MULTIBAND HUBBARD MODEL
M. Grilli, R. Raimondi, C. Castellani, C. DiCastro, and G. Kotliar (Rutgers Univ., Piscataway, NJ.) 30 Oct. 1990 13 p Submitted for publication
(Grant NSF SPL-89-15895)
(SSCL-Preprint-763; ETN-93-93655) Avail: CASI HC A03/MF A01

The three band Hubbard model with nearest neighbor resolution repulsion is studied in the U = infinity limit using the large N expansion technique to order 1/N. A charge transfer instability is found like in weak, coupling theory. At small doping, a major role is played by the Brinkman-Rice point. The charge transfer instability is always associated with a diverging compressibility leading to a phase separation. The evaluation to order 1/N of the effective scattering amplitude in the Cooper channel shows the presence of superconducting instabilities in the s and d wave channel near the phase separation. ESA

N93-27581# Rome Univ. (Italy). Dipt. di Fisica.
MEAN FIELD PHASE DIAGRAM OF TWO BAND tJ MODEL FOR CuO2 LAYERS
C. Castellani, M. Grilli, and G. Kotliar (Rutgers Univ., Piscataway, NJ.) 6 Nov. 1990 15 p Submitted for publication
(SSCL-Preprint-764; ETN-93-93656) Avail: CASI HC A03/MF A01

The mean field phase diagram of a two band tJ model is studied. By varying the doping and the values of the parameters, solutions with different magnetic structures without spin long range order are identified. A first order transition occurs between a uniform and a dimerized Fermi liquid phase. A second transition takes place between the dimerized Fermi liquid and an insulating fully dimerized phase. An instability region of negative compressibility where a phase separation occurs is found. At zero doping, a slater to charge transfer insulator transition where the compressibility vanishes together with the band dispersion is found. The results agree with those obtained in the J = 0 case and in the single band Hubbard model at the Brinkman-Rice transition. ESA

N93-27619# Sandia National Labs., Albuquerque, NM.
PARAMAGNETIC NITROGEN DEFECTS IN SILICON NITRIDE
W. L. Warren, J. Kanicki (International Business Machines Corp., Yorktown Heights, NY.), and J. Robertson (National Power Technology and Environmental Centre, Leatherhead, England.) 1992 10 p Presented at the 16th Material Research Society International Symposium on the Scientific Basis for Nuclear Waste Management Fall Meeting, Boston, MA, 30 Nov. - 5 Dec. 1992
(Contract DE-AC04-76DP-00789)
(DE93-008341; SAND-92-2777C; CONF-921101-99) Avail: CASI HC A02/MF A01

Photocreation mechanisms and properties of nitrogen dangling bonds in amorphous hydrogenated silicon nitride (a-SiN(x):H) thin films are investigated. We find that the creation kinetics are strongly dependent on the post-deposition anneal; this thermal process can be described by a simple exponential function which yields an activation energy of 0.8 eV. The compositional dependence of the nitrogen dangling bond center suggests that its energy level lies close to the valence band edge, in agreement with theoretical calculations. This energy level position can explain why a-SiN(x):H films often become conducting following a high post-deposition anneal. DOE

N93-27683# Cornell Univ., Ithaca, NY.
INNOVATIVE OPTOELECTRONIC MATERIALS AND STRUCTURES USING OMVPE Annual Report, 1 Jan. - 31 Dec. 1992
James R. Shealy 22 Mar. 1993 9 p
(Contract N00014-89-J-1311)
(AD-A262202) Avail: CASI HC A02/MF A01

An advanced OMVPE process is being developed for the deposition of III-V semiconductor materials and structures. There are important optoelectronic device structures which can not be realized by conventional means. The new OMVPE apparatus combines the multichamber reaction cell with deep UV photo-assisted growth and modulation flow epitaxial techniques. Using a combination of such processes, the growth temperature requirements for III-V alloys can be substantially reduced. Selective growth on a sub-micron scale will be attempted with in-situ interference holography. The materials and techniques developed in this research program will result in significant simplifications to the fabrication sequence required to realize complex integrated optoelectronic circuits. DTIC

N93-27690# Massachusetts Inst. of Tech., Cambridge. Dept. of Materials Science and Engineering.
DEVELOPMENT OF MODEL BASED MAGNETIC LP-LEC GROWTH OF LARGE DIAMETER GaAs Final Report, 15 Jun. 1991 - 14 Jun. 1992
August F. Witt 14 Jun. 1992 21 p
(Grant AF-AFOSR-0355-91)
(AD-A262361; AFOSR-93-0189TR) Avail: CASI HC A03/MF A01

The objective of this research was to explore the range of analytical information on the defect structure of doped and semi-insulating GaAs obtainable from computational, non-invasive, near infrared absorption analysis. Motivation for this research was provided by the realization that the establishment of meaningful property specifications for device materials is contingent on noninvasive defect analysis executable in a fabline environment. Infrared absorption measurements on a micro- and macro-scale in combination with computational image processing and analysis were found to meet the requirements of the stated research objectives. DTIC

N93-27700# Rome Univ. (Italy). Dipt. di Fisica.
PHASE TRANSITIONS IN THE DUAL LATTICE IN POTTS MODEL
A. M. Allega 24 Jul. 1990 19 p
(ROM1F-90-752; ETN-93-93663) Avail: CASI HC A03/MF A01

A system of topological linear exitations is produced in the dual cubic lattice of a three state Potts model in three dimensional dimensions. The order-disorder phase transitions are discussed by means of geometrical vortex-line quantities for pure ferromagnetic and mixed ferro-magnetic-antiferromagnetic spin interactions. Monte Carlo simulations are applied to calculate Potts dynamical spin configurations. A heath bath algorithm is employed to update 8 parallelized lattices storing the set of 8 spins in a single bit word. The Parisi-Rapuano random number generator is used. ESA

N93-27873# Technische Univ., Delft (Netherlands). Electronic Instrumentation Lab.
SPINNING-CURRENT METHOD FOR OFFSET REDUCTION IN SILICON HALL PLATES Ph.D. Thesis
Peter Jan Adriaan Munter 1992 153 p
(ISBN-90-6275-780-4/CIP; ETN-93-93599) Copyright Avail: CASI HC A08/MF A02

Research aimed at finding a truly offsetless silicon Hall plate is presented. Only the magnetic field sensitive Hall effect is of interest in Hall plates; all sources of offset, i.e. all other transduction effects, need to be reduced. The offset, which changes with packaging stress in the sensor housing, temperature and time, determines the minimum magnetic field that can be measured, typically 100 mT, without (periodically) calibrating the sensor. The only way to consistently reduce the varying sources of offset is to adaptively compensate them by means of a single sensor. The sources of offset in silicon Hall plates are categorized and the spinning current method is introduced as a novel way of separating the tranduction effects according to their current orientation dependence. An evaluation of the experiments conducted with spinning current Hall plates, with and without electronic circuitry, indicates that all sources of offset can be reduced in a consistent manner, independent of the packaging stress, temperature and time. The low residual offset of less than 100 microT is determined by only those sources of offset, which show the same current orientation independence as the Hall effect, i.e. the Peltier effect and inhomogeneities. On spinning current Hall plates, the offset is a factor of ten or more lower than in currently available orthogonally coupled Hall plates. ESA

N93-27913# Florida Univ., Gainesville. Dept. of Materials Science and Engineering.
VISIBLE LIGHT EMITTING MATERIALS AND INJECTION DEVICES Progress Report, 1 Jun. 1992 - 1 Jan. 1993
Paul H. Holloway 1 Jan. 1993 25 p
(Contract N00014-92-J-1895)
(AD-A263025) Avail: CASI HC A03/MF A01

Elemental sulfur and magnesium effusion sources were installed and calibrated. A second gas line and high-precision leak valve were installed on the RF plasma discharge source for generation of an atomic hydrogen beam and the hydrogen plasma was characterized using an optical emission spectroscopy apparatus. An RF plasma discharge, free-radical source was installed on the Varian Gen II MBE system. Gas lines were installed for both hydrogen and nitrogen free-radical production. Nitrogen and hydrogen plasmas were characterized using an optical emission spectroscopy apparatus. DTIC

N93-27922# New Mexico Univ., Albuquerque. Dept. of Chemistry.
DIRECT VISUALIZATION OF DEFECT STRUCTURES CONTAINED WITHIN SELF-ASSEMBLED ORGANOMERCAPTAN MONOLAYERS: COMBINED USE OF ELECTROCHEMISTRY AND SCANNING TUNNELING MICROSCOPY
Li Sun and Richard M. Crooks 19 Mar. 1993 26 p
(Contract N00014-91-J-1991)
(AD-A263031; TR-6) Avail: CASI HC A03/MF A01

Adventitious defects within self-assembled monolayers of 1-octadecanethiol confined to Au substrate have been studied by a new method which makes use of the high spatial resolution of scanning tunneling microscopy (STM) and the molecular specificity of electrochemistry. The method permits direct visualization of the defect density and provides information about the chemical and structural nature of the defects. CN was used to electrochemically etch Au from surface regions near defects. This leads to the formation of triangular etch pits, which exhibit a uniform in-plane orientation. A point-defect model is proposed to explain the orientation of the triangular pits. The model also predicts that the organomercaptan molecules occupy particular three-fold hollow sites. DTIC

N93-27926# Columbia Univ., New York, NY. Dept. of Electrical Engineering.
PSEUDOMORPHIC NARROW GAP MATERIALS FOR HIGH PERFORMANCE DEVICES Technical Report, 15 Feb. 1989 - 14 Dec. 1992
Wen I. Wang 14 Jan. 1993 14 p
(Contract N00014-90-J-1536)
(AD-A263069) Avail: CASI HC A03/MF A01

InAs field effect transistors (1 micrometer gate length) have been fabricated and showed extrinsic (intrinsic) transconductance as high as 414 mS/mm (670mS/mm). The cut-off frequency is shown to be more than a factor of two greater than is typical for GaAs based FET's with comparable gate length. Kink-free AlInAs/GaInAs/InP HEMT's have been fabricated. Heterojunction transistors with impact ionization at the emitter-base junction (i.e., when conduction band offset is larger than the band gap of the base) have been analyzed theoretically, and are shown to yield improved performance. Non-radiative Auger recombination in quantum wells has been analyzed in the context of strained lasers. We have also shown theoretically that infrared absorption at normal incidence due to intervalence subband transition can be greatly enhanced in light-hole and heavy-hole inverted strained GaInAs/AlInAs quantum wells. DTIC

N93-27935# Technische Univ., Delft (Netherlands).
STUDIES ON ZEOLITES: MOLECULAR MECHANICS, FRAMEWORK STABILITY, AND CRYSTAL GROWTH Ph.D. Thesis
Erik deVosBurchart 1992 197 p
(ETN-93-93613) Avail: CASI HC A09/MF A03

Molecular mechanics, framework stability, and crystal growth of zeolites and aluminophosphates, are studied. Both materials belong to the class of molecular sieves, which are important in the industry as ion exchangers,

catalysts and adsorbents. The faujasite structure is discussed with respect to the distribution of aluminum atoms and acid sites. Ordered growths between the zeolites X and A are described. Molecular mechanics of MFI type zeolites are studied for: effect of p-xylene adsorption in the zeolite structure; isomorphous substitution by aluminum; the monoclinic orthorhombic phase transition; energetics of crystal growth directing agents; alpha/beta quartz transition. Summation methods for the nonbonded interactions are compared. A consistent molecular mechanics force field for aluminophosphates was developed. A general discussion and conclusion is given covering optimization of force field, parameter set, and computer code. ESA

N93-27936# Technische Univ., Delft (Netherlands).
ZEOLITE CRYSTAL GROWTH AND THE STRUCTURE ON AN ATOMIC SCALE Ph.D. Thesis
J. C. Jansen 1992 148 p
(ETN-93-93615) Avail: CASI HC A07/MF A02

Aspects of zeolite ZSM-5 are studied. General considerations are given on silicas, silicates, zeolites and molecular sieves of the phosphate type. A literature survey of zeolite syntheses and experimental details acquired are presented. In order to characterize the structure of the framework and the guest molecule and the guest-guest and guest-framework interaction the zeolite ZSM-5 was prepared in different crystal sizes, 0.2 to 700 micrometers, whereafter, amongst others, the crystal structure determination of the as-synthesized material was carried out. To observe details of the zeolite external crystal surface, scanning tunneling microscopy was used to understand better the contribution of the external surface in catalysis performance. A scan was also made of the internal surface after cleaving a ZSM-5 single crystal. The parameters involved in the evolution of different crystal forms of the zeolite ZSM-5 were found by studying the crystal growth, in situ. A special lookthrough autoclave of 3 ml was made for this purpose. Chemical modifications like isomorphous substitution of various T-atoms to obtain different Bronsted acidity were studied. In order to develop layers, films and coatings of the zeolite ZSM-5 in different orientations on various supports, a study was carried out to understand parameters involved for catalysis, membrane and sensor applications. ESA

N93-27948# Varian Associates, Palo Alto, CA.
IMPROVED FIELD EMITTER CURRENT DENSITIES AND STABILITY THROUGH THE APPLICATION OF A PROPRIETARY PROCESS Quarterly Report No. 3, Sep. - Nov. 1992
Nov. 1992 8 p
(Contract MDA972-92-C-0033)
(AD-A261954) Avail: CASI HC A02/MF A01

As detailed in the previous reports, the necessary current density (60 A/sq cm), linear current density (3 mA/mm) and stability (greater than 2 days) to meet the contract goals (at least theoretically) have been achieved. The next step is to fabricate three terminal devices to demonstrate the remaining contract goal - a one GHz current gain cutoff frequency (f sub t). Unlike the traditional Spindt-type of emitter where, because of the circularly symmetric nature of the gate, the electrons can be emitted to an anode spaced at quite large distances away, the planar emitter-gate structure used for the single-crystal approach necessitates an anode spacing on the order of several microns to prevent a significant fraction of the emitted electrons from being collected by the gate. Hence the need to fabricate the 3-terminal devices monolithically. This report details the electron trajectory simulations needed for proper design of the three-terminal devices. DTIC

N93-27953# Naval Postgraduate School, Monterey, CA.
A SINGLE-TRANSISTOR MEMORY CELL AND SENSE AMPLIFIER FOR A GALLIUM ARSENIDE DYNAMIC RANDOM ACCESS MEMORY M.S. Thesis
Christopher B. Vagts Dec. 1992 97 p
(AD-A261975) Avail: CASI HC A05/MF A02

This thesis presents the design and layout of a Gallium Arsenide (GaAs) Dynamic Random Access Memory (DRAM) cell. Attempts have been made at producing GaAs DRAM cells, but these have dealt with modifications to the fabrication process, are expensive, and have met with little success. An eight-address by one-bit memory is designed, simulated, and laid out for a standard GaAs digital fabrication process. Three different configurations of RAM cells are considered: the Three-Transistor RAM Cell, the One-Transistor RAM Cell with a Diode, and the One-Transistor RAM Cell with a capacitor. All are tested and compared with the circuit simulator HSPICE. The chosen DRAM design uses the One-Transistor RAM Cell with a parallel plate capacitor and a five-transistor differential sense amplifier that handles reading as well as refresh of the memory cells. The differential sense amplifier compares a dummy cell with a memory cell to perform a read. The required timing is presented and demonstrated with read, write, and refresh cycles. Actions to minimize charge leakage are also considered and discussed. The design is simulated for access rates of approximately five nanoseconds, but the basic design can work at much faster rates with little modification. DTIC

N93-28140# Rome Univ. (Italy). Dept. of Physics.
SUPERCONDUCTIVITY, PHASE SEPARATION AND CHARGE TRANSFER INSTABILITY IN THE U = INFINITY LIMIT OF THE THREE BAND MODEL OF THE CuO2 PLANES
M. Grilli, R. Raimondi, C. Castellani, C. DiCastro, and G. Kotliar (Rutgers Univ., Piscataway, NJ.) 16 Jul. 1990 13 p Submitted for publication
(Grant NSF-89-15895)
(SSCL-Preprint-749; ETN-93-93642) Avail: CASI HC A03/MF A01

The U = infinity limit of the three band Hubbard model with nearest neighbors repulsion is studied using the slave boson approach and the large N expansion technique to order 1/N. A large transfer instability is found like in weak coupling theory. The charge transfer instability is always associated with a diverging compressibility leading to a phase separation. Near the phase separation region superconducting instabilities in the s and d wave channel are found. ESA

N93-28141# Rome Univ. (Italy). Dept. of Physics.
SUPERCONDUCTIVE FLUCTUATIONS IN THE DENSITY OF STATES AND TUNNELING RESISTANCE IN HIGH T(SUB c) SUPERCONDUCTORS
C. DiCastro, R. Raimondi, C. Castellani, and A. A. Varlamov (Consiglio Nazionale delle Ricerche, Naples , Italy.) 27 Jul. 1990 30 p Submitted for publication
(SSCL-Preprint-756; ETN-93-93648) Avail: CASI HC A03/MF A01

The effect of superconductive fluctuations in the density of states and tunneling resistance is reviewed in the case of dirty superconductors and derived for clean samples with and without pair breaking sources. For clean superconductors new features appear in the density of states. With respect to the commonly known dirty case, the fluctuation effects manifest thermselves in a new scale of energy with a different power law behavior as function of T - T(sub c). The relevance of these results for high T(sub c) superconductors is analyzed. ESA

N93-28144# Rome Univ. (Italy). Dept. of Physics.
PHASE SEPARATION AND SUPERCONDUCTIVITY IN THE KONDO-LIKE SPIN-HOLE COUPLED MODEL
N. Cancrini, S. Caprara, C. Castellani, C. DiCastro, M. Grilli, and R. Raimondi 28 Sep. 1990 13 p Submitted for publication
(SSCL-Preprint-759; ETN-93-93651) Avail: CASI HC A03/MF A01

The presence of a phase separation in the phase diagram of a Kondo-like spin-hole coupled model is investigated. Within a mean field analysis, it is found that the system in the normal phase separates into a spin liquid and a Fermi liquid phase. The introduction of a superconducting order parameter stabilizes the system by strongly reducing the phase separation region. A reasonable behavior of T(sub c) versus doping delta is also obtained. ESA

N93-28177# Naval Postgraduate School, Monterey, CA.
SOLID STATE X RAY DETECTOR CALIBRATION TECHNIQUES AND LINAC BEAM INTENSITY MEASUREMENTS M.S. Thesis
Thomas J. Fasanello, Jr. Dec. 1992 58 p
(AD-A262097) Avail: CASI HC A04/MF A01

X-ray fluorescence from thin foils inserted into the NPS linac have been used to measure the integrated electron beam current only. The measured x-ray flux and the known inner shell ionization cross sections are used to obtain measurements of dark currents of the order of ten to the minus fourteenth amperes. The same arrangement allows continuous, in-situ energy calibration of our Si(Li) detector in the electromagnetic noise

environment of the linac. This technique was originally developed to perform absolute production efficiency measurements of parametric x-ray generation in the 5-60 KeV range. DTIC

N93-28180# Case Western Reserve Univ., Cleveland, OH.
PSEUDOMORPHIC STABILIZATION OF DIAMOND ON NON-DIAMOND SUBSTRATES: HETEROEPITAXIALLY GROWN DIAMOND ON A c-BN(111) SURFACE Interim Report, 1 Oct. 1992 - 31 Jan. 1993
L. Wang, A. Argoitia, J. S. Ma, J. C. Angus, and P. Pirouz 8 Feb. 1993 14 p
(Contract N00014-89-J-1631)
(AD-A262106) Avail: CASI HC A03/MF A01

A continuous diamond film with a thickness of about 10 microns was grown on (111) faces of single crystal cubic boron nitride (c-BN) by hot-filament chemical vapor deposition (CVD). The morphology and microstructure of the diamond film were investigated by scanning and transmission electron microscopy. Cross-sectional selected area diffraction pattern (SADP) and high resolution electron microscopy (HREM) of the diamond/c-BN interface show that the diamond has a parallel orientation relationship with respect to the substrate. Indirect evidence from scanning electron microscopy indicates that parallel epitaxy was achieved over the entire boron terminated face of the c-BN crystal, which had linear dimensions of approximately 400 microns. DTIC

N93-28216# Texas Univ., Austin. Dept. of Chemistry and Biochemistry.
ELECTRON TRANSFER REACTIONS IN MICROPOROUS SOLIDS
T. E. Mallouk Jan. 1993 26 p
(Contract DE-FG05-87ER-13789)
(DE93-011261; DOE/ER-13789/6) Avail: CASI HC A03/MF A01

The research program involves the use of microporous solids (zeolites, clays, layered, and tunnel structure oxide semiconductors) as organizing media for artificial photosynthetic systems. The purpose of the microporous solid is twofold. First, it induces spatial organization of photoactive and electroactive components (sensitizers, semiconductor particles, electron relays, and catalysts) at the solid-solution interface, enhancing the quantum efficiency of charge separation and separating physically the ultimate electron donor and acceptor in the electron transport chain. Second, since the microcrystalline solid admits only molecules of a certain charge and size, it is possible to achieve permanent charge separation by sieving chemical photoproducts (e.g., H2 and I3(-), or H2 and O2) from each other. Spectroscopic and electrochemical methods are used to study the kinetics of electron transfer reactions in these hybrid molecular/solid state assemblies. DOE

N93-28237# Massachusetts Inst. of Tech., Lexington. Lincoln Lab.
SOLID STATE RESEARCH Quarterly Technical Report, 1 May - 31 Jul. 1992
Alan L. McWhorter 15 Aug. 1992 84 p
(Contract F19628-90-C-0002)
(AD-A262273; SSR-1992-3; ESC-TR-92-149) Avail: CASI HC A05/MF A01

This report covers in detail the research work of the Solid State Division at Lincoln Laboratory for the period 1 May through 31 July 1992. The topics covered are Electrooptical Devices, Quantum Electronics, Materials Research, Submicrometer Technology, High Speed Electronics, Microelectronics, and Analog Device Technology. DTIC

N93-28247# Massachusetts Inst. of Tech., Lexington. Lincoln Lab.
SOLID STATE RESEARCH Quarterly Technical Report, 1 Aug. - 31 Oct. 1992
Alan L. McWhorter 26 Feb. 1993 62 p
(Contract F19628-90-C-0002)
(AD-A262874; ESC-TR-92-194) Avail: CASI HC A04/MF A01

This report covers in detail the research work of the Solid State Division at Lincoln Laboratory for the period 1 August through 31 October 1992. The topics covered are Electrooptical Devices, Quantum Electronics, Materials Research, Submicrometer Technology, High Speed Electronics, Microelectronics, and Analog Device Technology. Funding is provided primarily by the Air Force, with additional support provided by the Army, DARPA, Navy, SDIO, and NASA. DTIC

N93-28304# Carnegie-Mellon Univ., Pittsburgh, PA.
DEVELOPMENT OF GERMANIUM-SILICON GROWTH TECHNOLOGY Annual Report, 1 Feb. 1992 - 31 Jan. 1993
D. W. Greve 24 Feb. 1993 15 p
(Contract F49620-92-J-0155)
(AD-A262891; AFOSR-93-0165TR) Avail: CASI HC A03/MF A01

The growth of heterojunction internal photoemission detectors and multiple quantum well detectors for the far-infrared has been explored. Structures have been grown using ultrahigh vacuum chemical vapor deposition and have been characterized with x-ray diffraction, SIMS, RBS, and photoluminescence. Infrared response has been observed in some structures. Characterization performed to date has permitted the identification of growth parameters for experiments which will be performed in the next year. DTIC

N93-28311# Argonne National Lab., IL.
DIAMOND MONOCHROMATOR FOR HIGH HEAT FLUX SYNCHROTRON X RAY BEAMS
A. M. Khounsary, R. K. Smither, S. Davey, and A. Purohit Dec. 1992 16 p Presented at the Society of Photo-Optical Instrumentation Engineers (SPIE) International Symposium on Optical Applied Science and Engineering, San Diego, CA, 19-24 Jul. 1992
(Contract W-31-109-eng-38)
(DE93-006799; ANL/XFD/CP-78515; CONF-920792-46) Avail: CASI HC A03/MF A01

Single crystal silicon has been the material of choice for x-ray monochromators for the past several decades. However, the need for suitable monochromators to handle the high heat load of the next generation synchrotron x-ray beams on the one hand and the rapid and on-going advances in synthetic diamond technology on the other make a compelling case for the consideration of a diamond mollochromator system. In this paper, we consider various aspects, advantage and disadvantages, and promises and pitfalls of such a system and evaluate the comparative an monochromator subjected to the high heat load of the most powerful x-ray beam that will become available in the next few years. The results of experiments performed to evaluate the diffraction properties of a currently available synthetic single crystal diamond are also presented. Fabrication of diamond-based monochromator is within present technical means. DOE

N93-28346# Pennsylvania Univ., Philadelphia. Dept. of Physics.
CONDENSED MATTER PHYSICS AT SURFACES AND INTERFACES OF SOLIDS
E. Mele Nov. 1992 14 p
(Contract DE-FG02-84ER-45118)
(DE93-005648; DOE/ER-45118/8) Avail: CASI HC A03/MF A01

The objectives of the research are to develop a microscopic theory for the structural and electronic properties of condensed phases of matter, with an emphasis on new phenomena appearing in low-dimensional systems, including surfaces of solids, at interfaces between solids, conducting polymers, and fullerides. Recent results are noted in the following areas: surface phonons and dimer ordering on Si (001), surface phonons at low index surfaces of Be, and disorder and superconductivity in doped fullerides. DOE

N93-28347# Ames Lab., IA.
RADIATION INDUCED FLUX PINNING IN YBa2Cu3O(7-DELTA) SINGLE CRYSTAL Ph.D. Thesis
Qiang Qian Feb. 1993 108 p
(Contract W-7405-eng-82)
(DE93-008823; IS-T-1452) Avail: CASI HC A06/MF A02

Radiation damage studies have been carried out to determine the changes in superconducting critical current density that result for different choices of radiation direction and magnetic field direction relative to the crystallographic axes. Single crystals of YBa2Cu3O(7 - delta) were irradiated with 200 MeV protons parallel the a-b plane or to c-axis. These beams created light damage in form of interstitials and voids that subsequently coalesced to clusters of extra atoms in the a-b plane directed along the (100) direction. For low fluence, the main change was in the c-axis critical current density, J(sub c)(sup c). For fluence in the 10(exp 12) - 10(exp 14) protons/sq cm range, J(sub c)(sup c) showed a major increase whereas the in-plane critical current density, J(sub c)(sup ab) increased much less.

There also was a large in-plane anisotropy of J(sub c)(sup c) with J(sub c)(sup c) five to ten times larger for the field parallel to the damage tracks. For fluences in the range of 10(exp 16) protons/sq cm both J(sub c)(sup c) and J(sub c)(sup ab) showed large increases to values in the 2(10)(exp 6) A/sq cm range. Annealing studies at room temperature showed that both J(sub c)(sup c)and J(sub c)(sup ab) decreased 20 to 30%. DOE

N93-28354# Argonne National Lab., IL.
SYNTHESIS AND PROCESSING OF NANOSTRUCTURED MATERIALS
R. W. Siegel Dec. 1992 31 p Presented at the NATO Advanced Study Institute on Mechanical Properties of Materials Having Ultra-Fine Microstructure, Porto Novo, Portugal, 17 Jun. - 10 Jul. 1992
(Contract W-31-109-eng-38)
(DE93-006413; ANL/MSD/CP-75657; CONF-9206271-4) Avail: CASI HC A03/MF A01

Significant and growing interest is being exhibited in the novel and enhanced properties of nanostructured materials. These materials, with their constituent phase or grain structures modulated on a length scale less than 100 nm, are artificially synthesized by a wide variety of physical, chemical, and mechanical methods. In this NATO Advanced Study Institute, where mechanical behavior is emphasized, nanostructured materials with modulation dimensionalities from one (multilayers) to three (nanophase materials) are mainly considered. No attempt is made in this review to cover in detail all of the diverse methods available for the synthesis of nanostructured materials. Rather, the basic principles involved in their synthesis are discussed in terms of the special properties sought using examples of particular synthesis and processing methodologies. Some examples of the property changes that can result from one of these methods, cluster assembly of nanophase materials, are presented. DOE

N93-26928*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
SILICON CARBIDE SEMICONDUCTOR TECHNOLOGY FOR HIGH TEMPERATURE AND RADIATION ENVIRONMENTS
Lawrence G. Matus *In its* Nuclear Propulsion Technical Interchange Meeting, Volume 1 1993 p 445-452 (For primary document see N93-26908 10-20)
Avail: CASI HC A02/MF A04

N93-27763*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
FABRICATION AND CHARACTERIZATION OF HIGH CURRENT-DENSITY, SUBMICRON, NbN/MgO/NbN TUNNEL JUNCTIONS
J. A. Stern, Henry G. LeDuc, and A. J. Judas *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 420-438 Sponsored in part by Strategic Defense Initiative Organization (For primary document see N93-27726 10-31)
Avail: CASI HC A03/MF A06

77 THERMODYNAMICS AND STATISTICAL PHYSICS

Includes quantum mechanics; theoretical physics; and Bose and Fermi statistics.

For related information see also *25 Inorganic and Physical Chemistry* and *34 Fluid Mechanics and Heat Transfer.*

N93-26637# Helsinki Univ. of Technology, Espoo (Finland). Lab. of Metallurgy.
THERMODYNAMIC ANALYSIS OF THE BINARY SYSTEMS Mo-V, Ni-V, Si-V, AND Ti-V
R. Luoma 1992 32 p
(PB93-173185; TKK-V-B76) Avail: CASI HC A03/MF A01

Thermodynamic properties and the phase diagrams of the binary systems Mo-V, Ni-V, Si-V, and Ti-V have been critically assessed by the Lukas program using, simultaneously, thermodynamic and phase diagram measurements. The assessed binary phase diagrams were in good agreement with those found in the literature. The complete and internally consistent Gibbs energy expressions for alloy phases were presented allowing calculations of the phase diagrams and the thermodynamic properties of the phases. NTIS

N93-27306# Nationaal Inst. voor Kernfysica en Hoge Energiefysica, Amsterdam (Netherlands).
CLASSICAL AND QUANTUM MECHANICS OF A SPINNING PARTICLE INTERACTING WITH ANTI-SYMMETRIC NON-ABELIAN TENSOR FIELDS
R. H. Rietdijk 18 Dec. 1991 16 p
(NIKHEF-H/92-1; ETN-93-93297) Avail: CASI HC A03/MF A01

The spinning particle interacting in a supersymmetric and gauge invariant way with antisymmetric nonabelian tensor fields is studied. A quantum theory is presented. The Witten index for the corresponding Dirac operator is calculated. The results show that the antisymmetric nonabelian tensor fields do not give any contribution to it. It is found that only the gravitational field g(sub mu nu) and the one index gauge field sub nu give contributions to the index. The antisymmetric tensor fields only yield globally defined exact forms. ESA

N93-27307# Nationaal Inst. voor Kernfysica en Hoge Energiefysica, Amsterdam (Netherlands).
OPERATOR ALGEBRA FROM FUSION RULES 2: IMPLEMENTING APPARENT SINGULARITIES
Juergen Fuchs Feb. 1992 32 p
(NIKHEF-H/92-06; ETN-93-93299) Avail: CASI HC A03/MF A01

The role of apparent singularities for the four point correlation functions in the sphere is investigated. In particular, the restrictions imposed on them for general principles of two dimensional conformal field theory are worked out, and the implications on the classification program are discussed. The construction of linear ordinary differential equations for four point correlators from the data of a conformal field theory defined in the plane are described. Some basic information about linear ordinary differential equation, with emphasis in the aspects related with apparent singularities are provided. These results are set into the context of four point functions of rational conformal field theories. An example of first order differential equations is worked out. For higher order equations, explicit formulae are much more difficult to establish; some considerations on how to handle these cases by making use of an isomonodromic deformation of the differential equation are given. Remarks on the special case of correlation functions of WZW theories are added. Conclusions are summarized and the possible existence of continuous families of rational conformal field theories is considered. ESA

N93-27395# Groningen Rijksuniv. (Netherlands). Kernfysisch Versneller Inst.
FLUCTUATIONS IN QUANTUM TRANSPORT THEORIES OF NUCLEAR MATTER
R. Malfliet 1992 10 p Presented at the International Workshop on Dynamical Fluctuations and Correlations in Nuclear Collisions, Aussois, France, 16-20 Mar. 1992
(KVI-930; ETN-93-93342) Avail: CASI HC A02/MF A01

The so called Kadanoff-Baym equations are used as a starting point for studying the occurrence of quantum fluctuations and their relevance for transport phenomena in nuclear matter. The derivations of Kadanoff-Baym equations are obtained by using Keldysh technique for real time Green's functions. The occurrence of correlations and fluctuations and correlations in the equations are studied. How the Kadanoff-Baym kinetic equations can be reduced to a simplified form is presented. A model which allows the comparison between quantum and classical relaxation properties is given. ESA

N93-27496# Nationaal Inst. voor Kernfysica en Hoge Energiefysica, Amsterdam (Netherlands).
THE MATHAI-QUILLEN FORMALISM AND TOPOLOGICAL FIELD THEORY
Matthias Blau 9 Mar. 1992 34 p Presented at the Karpacz Winter School on Infinite Dimensional Geometry in Physics, 17-27 Feb. 1992 Sponsored by Stichting voor Fundamenteel Onderzoek der Materie, Netherlands
(NIKHEF-H/92-07; ETN-93-93300) Avail: CASI HC A03/MF A01

An approach to cohomological field theory which is based on the

construction of Gaussian shaped Thom forms by Mathai and Quillen is given. Topics covered are: an explanation of the Mathai-Quillen formalism for finite dimensional vector bundles; the definition of regularized Euler numbers of infinite dimensional vector bundles; interpretation of supersymmetric quantum mechanics as the regularized Euler number of loop space; the Atiyah-Jeffrey interpretation of Donaldson theory; and the construction of topological gauge theories from infinite dimensional vector bundles over spaces of connections. ESA

N93-27509# Nationaal Inst. voor Kernfysica en Hoge Energiefysica, Amsterdam (Netherlands).

THE N EQUALS 2 TOPOLOGICAL GAUGE THEORY, THE EULER CHARACTERISTIC OF MODULI SPACES, AND THE CASSON INVARIANT

Matthias Blau and George Thompson (Mainz Univ., Germany.) Nov. 1991 40 p Sponsored by Stichting voor Fundamenteel Onderzoek der Materie, Netherlands

(Contract BMFT-06MZ760)

(NIKHEF-H/91-28; MZ-TH/91-40; ETN-93-93296) Avail: CASI HC A03/MF A01

The gauge theory with a topological N = 2 symmetry is discussed. This theory captures the de Rham complex and Riemannian geometry of some underlying moduli space M and the partition function equals the Euler number chi(M) of M. Moduli spaces of instantons and of flat connections in two and three dimensions are considered. The relation between the Mathai-Quillen formalism and supersymmetric quantum mechanics is explained. A new kind of supersymmetric quantum mechanics based on the Gauss-Codazzi equations is introduced. The gauge theory actions are interpreted from the Atiyah-Jeffrey point of view and related to supersymmetric quantum mechanics in spaces of connections. The Euler number chi(M) of the moduli space of flat connections is generalized to arbitrary three manifolds of the Casson invariant. The possibility of constructing a topological version of the Penner matrix model is considered. ESA

N93-27511# Nationaal Inst. voor Kernfysica en Hoge Energiefysica, Amsterdam (Netherlands).

SPINNING PARTICLES IN SCHWARZSCHILD SPACE-TIME

R. H. Rietdijk and J. W. vanHolten 1992 26 p Sponsored by Stichting voor Fundamenteel Onderzoek der Materie, Netherlands

(NIKHEF-H/92-09; ETN-93-93302) Avail: CASI HC A03/MF A01

The motion of pseudo-classical spinning particles in a static, spherically symmetric space time is analyzed. The purpose of the work is to show how generalizations of the usual Killing equations and Noether's theorem for particles with internal degrees of freedom like spin can be used to obtain information about the solutions of the equations of motion of these particles in curved space time. Relevant equations for the motion of spinning particles in curved space-time are summarized. The generalized Killing equations for spinning space and the derivation of constants of motion in terms of the solutions of these equations are given. These results are applied to the case of static, spherically symmetric gravitational fields, as described by the Schwarzschild solution of Einstein's equations. Specific solutions, and an exact equation for the precession of the perihelion of planar orbits are discussed. The results and conclusions are summarized. ESA

N93-27583# Rome Univ. (Italy). Dipt. di Fisica.

EXTENDED PURE YANG MILLS GAUGE THEORIES WITH SCALAR AND TENSOR GAUGE FIELDS

Emidio Gabrielli (Istituto Nazionale di Fisica Nucleare, Rome, Italy.) 26 Nov. 1990 11 p Submitted for publication

(SSCL-Preprint-769; ETN-93-93659) Avail: CASI HC A03/MF A01

The usual abelian gauge theory is extended to an interacting Yang Mills like theory containing vector, scalar, and tensor gauge fields. These gauge fields are seen as components along the Clifford algebra basis of a gauge vector-spinorial field. Scalar fields phi naturally coupled to vector and tensor fields are found, leading to a natural phi(sup 4) coupling in the Lagrangian. The full expression of the Lagrangian for the euclidean version of the theory is given. ESA

N93-27584# Rome Univ. (Italy). Dipt. di Fisica.

CONVERGENCE OF COMPACT LATTICE SCALAR FIELD THEORY TO ITS CONTINUUM LIMIT

Stefano Capitani (Istituto Nazionale di Fisica Nucleare, Rome, Italy.) 17 Dec. 1990 19 p Submitted for publication

(SSCL-Preprint-771; ETN-93-93660) Avail: CASI HC A03/MF A01

The convergence of the compact lattice scalar field theory is investigated. An independent parameter, namely the cardinality lambda of the links of the lattice is introduced. The compact lattice scalar field is shown to be convergent in the sense of the correlation functions to its continuum limit when simultaneously the lattice spacing tends to zero and the amplitude cutoff and the lattice volume go to infinity. This is achieved in any number of dimensions provided that the last two parameters go to infinity not too rapidly. Besides, it is proved the right upper bound to the limit with no condition in the way it is performed. ESA

N93-27952# Army Research Lab., Aberdeen Proving Ground, MD.

THE EFFECTS OF SMALL CHANGES IN THE INPUT DATA ON THE DETERMINATION OF CLOSED-BOMB BURNING RATES AND SURFACE AREA Final Report, Oct. 1989 - Oct. 1990

Frederick W. Robbins and Karen A. Cieslewicz Mar. 1993 88 p

(DA Proj. 1L1-62618-AH-80)

(AD-A261969; ARL-TR-83) Avail: CASI HC A05/MF A01

In order to ascertain the effects of small changes in the input data on the determination of closed-bomb burning rates, a series of related computer programs was developed. The computer programs allow a qualitative and quantitative evaluation of the effects of varying thermodynamic properties and, if desired, the propellant grain dimensions. Program listings and sample runs are included, along with Fortran listings of common form functions. DTIC

N93-28068 New York Univ., New York.

TRANSFORMATION OF THE KEPLER PROBLEM Ph.D. Thesis

Marcel Reginatto 1992 88 p

Avail: Univ. Microfilms Order No. DA9306803

The connection between the Kepler problem and the oscillator is examined both in classical and quantum mechanics, and transformations that map bound orbits of the Kepler problem in two and three dimensions to oscillator orbits are derived. The classical transformations are canonical and act in the extended phase space of the system. The transformation that maps the three dimensional Kepler problem provides an alternative to the Kustaanheimo-Stiefel transformation. From it a transformation of space and time coordinates that maps the Hamilton Jacobi equation of the three dimensional Kepler problem to that of the oscillator is derived. The corresponding quantum transformations of Hilbert spaces are written in terms of the generating functions of the classical transformations. Quasi-classical states of the Kepler problem are constructed by transforming oscillator coherent states, and the time evolution of such states is briefly discussed. Dissert. Abstr.

N93-28096# Rome Univ. (Italy). Dept. of Physics.

A BOSON FIELD STOCHASTIC CALCULUS AND QUANTUM FILTERING IN FOCK SPACE

V. P. Belavkin 29 Dec. 1989 29 p Submitted for publication

(SSCL-Preprint-723; ETN-93-93624) Avail: CASI HC A03/MF A01

A Quantum Stochastic (QS) multiple integration of boson fields in a continuous set X is developed. The calculus of nondemolition processes of continuous observation in Fock space over L to the 2nd power (X) is presented. A natural integrability condition for the existence and uniqueness of the solution of linear QS evolution equations is given. A stochastic linear filtering equation as a quantum generalization of Zakai equation for a general observable process is derived. A unique filtering problem in the form of a multiple stochastic integral is found by resolving the corresponding wave stochastic evolution equation describing the posterior dynamics of a quantum object under the complete nondemolition observation. ESA

N93-28145# Rome Univ. (Italy). Dept. of Physics.

VARIATIONAL METHODS IN GENERAL RELATIVITY: MITTELEUROPEAN MATHEMATICAL INACCURACY AND ITALIAN RIGOUR. THE CONTRIBUTION OF A. PALATINI

Carlo Cattani 5 Oct. 1990 33 p Submitted for publication Sponsored

in part by the Ministry of University and Scientific and Technological Research, Italy, and CNR, Italy
(SSCL-Preprint-760; ETN-93-93652) Avail: CASI HC A03/MF A01

The debate from 1915 to 1919 about the correct formulation of the variational principle for gravitational field equations is discussed. The contributions of Einstein, Lorentz, Hilbert, Levi-Civita, and Palatini are analyzed. Palatini's attempts to develop a covariant variational approach to general relatively, with particular regard to the hypothesis in matter coupled with gravity, are reconstructed. His scientific works and private correspondence during the years 1920 to 1938 are summarized. The role played by Levi-Civita in Palatini's variational method is outlined. His method is discussed with special attention to the difficulties concerning the physically meaningless hypothesis regarding the dependence of the stress-energy tensor for matter in the gravitational potentials. ESA

N93-28162# Rome Univ. (Italy). Dept. of Physics.
THE IMPROVEMENT OF HADRONIC MATRIX ELEMENTS IN LATTICE QCD
G. Heatlie (Southampton Univ., England.), G. Martinelli, C. Pittori, G. C. Rossi (Aquila Univ., Italy.), and C. T. Sachrajda (Southampton Univ., England.) 27 Apr. 1990 28 p Submitted for publication Sponsored by Ministry of University and Scientific and Technological Research, Italy, and United Kingdom Science and Engineering Research Council
(SSCL-Preprint-737; Shap-89/90-9; ETN-93-93630) Avail: CASI HC A03/MF A01

A method to eliminate all terms of order a (a being the lattice spacing) in the Quantum Chromodynamics (CQD) calculations of hadronic matrix elements with Wilson fermions is presented. The method is based on an 'improved' Wilson action combined with a modification of the fermion operators. With this technique one expects to reduce signficantly the systematic errors which arise due to the finiteness of the lattice spacing. These errors can be reduced from about 20 to 30% to just a few percent. ESA

N93-28194# Rome Univ. (Italy). Dept. of Physics.
THE GRIBOV PROBLEM IN THE FRAME OF STOCHASTIC QUANTIZATION
Claudio Parrinello 7 May 1990 4 p Submitted for publication
(SSCL-Preprint-740; ETN-93-93633) Avail: CASI HC A01/MF A01

A review of a Gribov problem in the Landau gauge, from the point of view of stochastic quantization is given. A numerical investigation based on a minimization algorithm, is discussed. Information about Gribov copies within the first Gribov horizon are presented. ESA

N93-28197# Rome Univ. (Italy). Dept. of Physics.
COMPLEX GEOMETRY AND STRING THEORY
A. Y. Morozov (Academy of Sciences, USSR, Moscow.) and A. M. Perelomov (Academy of Sciences, USSR, Moscow.) 28 Jun. 1990 18 p Submitted for publication
(SSCL-Preprint-746; ETN-93-93639) Avail: CASI HC A03/MF A01

The analytic properties of string theory are reviewed. It is demonstrated that the theory of strings is connected with contemporary fields of complex geometry. A massless classical point-like particle which moves in Minkowski space of D dimensions is considered. The formulation used to develop string theory is based on the Polyakov approach. In order to find the quantum scattering amplitude in the Polyakov approach, the functional integral over all Riemannian surfaces is calculated. The simplest case of the amplitude of vacuum-vacuum transitions Z of a closed string is considered. The description of linear bundles in the divisor terms is given. ESA

N93-28209# Rome Univ. (Italy). Dept. of Physics.
A MODIFIED FADDEEV-POPOV FORMULA AND THE GRIBOV AMBIGUITY
C. Parrinello (Consiglio Nazionale delle Ricerche, Rome, Italy.) and G. Jona-Lasinio (Istituto Nazionale di Fisica Nucleare, Rome, Italy.) 20 Jul. 1990 13 p Submitted for publication
(SSCL-Preprint-750; ETN-93-93643) Avail: CASI HC A03/MF A01

A new path integral formula for Yang-Mills theories is proposed. It contains a gauge fixing prescription expressed by a nonlocal gauge fixing term, that takes into account the problem of Gribov copies. A natural approximation of this formula, leading to an explicit expression is presented. The latter implements Gribov's original idea of restricting the domain of integration in the Faddeev-Popov formula to the first horizon and can be compared with similar expressions obtained within the stochastic quantization of gauge theories. ESA

N93-28210# Rome Univ. (Italy). Dept. of Physics.
LOCALIZED SOLUTIONS OF N + 1 DIMENSIONAL EVOLUTION EQUATIONS
A. Degasperis (Istituto Nazionale di Fisica Nucleare, Rome, Italy.) and P. C. Sabatier (Universite des Sciences et Techniques du Languedoc, Montpellier, France.) 24 Jul. 1990 12 p Submitted for publication
(SSCL-Preprint-753; ETN-93-93645) Avail: CASI HC A03/MF A01

A method for constructing nonlinear Schroedinger equations in N + 1 dimensions is given. These equations are similar to the Davey-Stewartson equation and possess, by construction, solutions describing interacting soliton-like objects. Solitons are localized, nondispersive, interactive waves, and their particle like properties are due to either integrability of the evolution equation by spectral transforms or the solvability by a change of variables. The approach presented applies to any number N of space dimensions and for N = 1 it reproduces the Eckaus equation. For N = 2 the Davey-Stewartson equation is obtained. For N greater than 2, nonlinear partial differential equations are derived and a class of multi-soliton solutions is constructed. ESA

N93-28211# Rome Univ. (Italy). Dept. of Physics.
HADRON STRUCTURE ON THE LATTICE
Guido Martinelli (Istituto Nazionale di Fisica Nucleare, Rome, Italy.) 25 Jul. 1990 24 p Submitted for publication
(SSCL-Preprint-754; ETN-93-93646) Avail: CASI HC A03/MF A01

Lattice calculations of hadronic matrix elements are reviewed. Two examples are discussed: D semileptonic decays and the pseudoscalar meson decay constant, f(sub B). The lattice predictions for the decays D to k and D to k(star) are reported. The lattice results are valuable because no extra assumptions or arbitary parameters are induced. A sensible improvement of the accuracy of the lattice calculation can be obtained by studying SV(3) braking effects and terms of order lambda (sub QCD)a(sup 62). The main result from the lattice calculation of pseudoscalar meson decay constant, in the limit of an infinitely heavy quark, is that corrections to the asymptotic behavior, due to 1/m(sub Q) terms, are of about 65% for charmed mesons and 25% for B mesons. ESA

N93-28312# Washington Univ., Seattle. Dept. of Physics.
RECENT PROGRESS IN LATTICE QCD
S. R. Sharpe Dec. 1992 17 p Presented at the Meeting of the Division of Particles and Fields of the American Physics Society, Batavia, IL, 10-14 Nov. 1992
(Contract DE-FG06-91ER-40614)
(DE93-006827; DOE/ER-40614/37; CONF-921122-39) Avail: CASI HC A03/MF A01

A brief overview of the status of lattice QCD is given, with emphasis on topics relevant to phenomenology. The calculation of the light quark spectrum, the lattice prediction of (alpha) (sub (bar MS))(M (sub Z)), and the calculation of f(sub B) are discussed. DOE

N93-28315# Rome Univ. (Italy). Dept. of Physics.
ZEEMAN SPIN SPLITTING FREQUENCY RENORMALIZATION IN DISORDERED INTERACTING ELECTRONIC SYSTEMS
R. Raimondi, C. Castellani, and C. DiCastro 27 Jul. 1990 37 p Submitted for publication
(SSCL-Preprint-755; ETN-93-93647) Avail: CASI HC A03/MF A01

At low temperatures, the magnetic field affects the thermodynamic and transport properties of interacting disordered electronic systems via the Zeeman spin splitting frequency. It is shown that this frequency always appears multiplied by the spin Fermi liquid factor and renormalizes as the spin susceptibility, resulting in an enhanced magnetic field. This result is derived from perturbation theory and renormalization group analysis and implements the Ward identities derived for the spin vertices in the presence of the magnetic field. The implications of this result in the weak and strong localization regime are discussed. ESA

N93-28350# Houston Univ., TX. Dept. of Mechanical Engineering.
HIGH FLUX FILM AND TRANSITION BOILING

L. C. Witte Feb. 1993 8 p
(Contract DE-FG05-88ER-13893)
(DE93-010917; DOE/ER-13893/T1) Avail: CASI HC A02/MF A01

An investigation was conducted on the potential for altering the boiling curve through effects of high velocity and high subcooling. Experiments using water and Freon-113 flowing over cylindrical electrical heaters in crossflow were made to see how velocity and subcooling affect the boiling curve, especially the film and transition boiling regions. We sought subcooling levels down to near the freezing points of these two liquids to prove the concept that the critical heat flux and the minimum heat flux could be brought together, thereby averting the transition region altogether. Another emphasis was to gain insight into how the various boiling regions could be represented mathematically on various parts of the heating surface. Motivation for the research grew out of a realization that the effects of very high subcooling and velocity might be to avert the transition boiling altogether so that the unstable part of the boiling curve would not limit the application of high flux devices to temperatures less than the burnout temperatures. Summaries of results from the study are described. It shows that the potential for averting the transition region is good and points the way to further research that is needed to demonstrate the potential. DOE

N93-28386# Rome Univ. (Italy). Dept. of Physics.
QUANTUM NON-DEMOLITION MEASUREMENTS AND GENERALIZED STATES AT THERMAL EQUILIBRIUM
Roberto Onofrio (Istituto Nazionale di Fisica Nucleare, Rome, Italy.) 30 May 1990 10 p Submitted for publication
(SSCL-Preprint-743; ETN-93-93636) Avail: CASI HC A02/MF A01

The measurements on a macroscopic mechanical oscillator through an electromagnetic read out are discussed. The classical and the quantum regime of sensitivity are considered. It is shown that indirect quantum non demolition meaurements allow the introduction of generalized states at thermal equilibrium having different temperatures for the two complex amplitudes of the same oscillator. An Hamiltonian interaction is proposed for squeezing mechanical fluctuations through indirect quantum non demolition measurements and phase sensitive amplifiers. ESA

N93-28461# Los Alamos National Lab., NM.
BEYOND METRIC GRAVITY: PROGRESS ON PS-200
T. Goldman, R. E. Brown, J. B. Camp, T. Darling, P. Dyer, M. H. Holzscheiter, R. J. Hughes, N. Jarmie, N. S. P. King, and D. C. Lizon et al 1993 10 p Presented at the Workshop on Traps for Antimatter and Radioactive Nuclei, Vancouver, Ottawa, 25-27 Feb. 1993
(Contract W-7405-eng-36)
(DE93-008723; LA-UR-93-721; CONF-930274-1) Avail: CASI HC A02/MF A01

The reconciliation of quantum mechanics and gravity on varying distance scales requires changes to General Relativity that may have testable implications. We briefly review the status of tests with matter of the inverse square law and the principle of equivalence, then report on progress on the drift-tube measurement section of PS-200, the experiment to measure the gravitational acceleration of antiprotons. DOE

N93-28462# Los Alamos National Lab., NM.
FOUR DIMENSIONAL QUANTUM GRAVITY: THE COVARIANT PATH INTEGRAL AND QUANTIZATION OF THE CONFORMAL FACTOR
E. Mottola 1993 46 p Presented at the First Iberian Meeting on Gravity, Evora, Portugal, 20-26 Sep. 1992
(Contract W-7405-eng-36)
(DE93-008726; LA-UR-93-679; CONF-9209322-1) Avail: CASI HC A03/MF A01

After first reviewing the issue of vacuum energy (the cosmological constant problem) in the Einstein theory, the covariant path integral for gravity in four dimensions is constructed. The problem of vacuum energy requires determining the correct ground state of the quantum theory of gravity, and as such is an infrared problem, arising prior to and independently of the physics of the Planck scale. It is addressed in these lectures by studying the infrared fixed point of the low energy effective action of the conformal factor generated by the quantum trace anomaly in four dimensions. The infrared fixed point of this effective theory describes a conformally invariant phase of gravity with a vanishing effective cosmological term. DOE

N93-27312*# Maryland Univ., College Park. Dept. of Physics and Astronomy.
QUONS, AN INTERPOLATION BETWEEN BOSE AND FERMI OSCILLATORS
O. W. Greenberg *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 5-18 Sponsored in part by NSF (For primary document see N93-27311 10-74)
Avail: CASI HC A03/MF A04

N93-27313*# Florida Univ., Gainesville. Dept. of Physics and Mathematics.
THE UNIVERSAL PROPAGATOR
John R. Klauder *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 19-28 (For primary document see N93-27311 10-74)
Avail: CASI HC A02/MF A04

N93-27314*# Montreal Univ. (Quebec).
PHASE-SPACE QUANTUM MECHANICS STUDY OF TWO IDENTICAL PARTICLES IN AN EXTERNAL OSCILLATORY POTENTIAL
Luis M. Nieto (Valladolid Univ., Spain.) and Manuel Gadella (Valladolid Univ., Spain.) *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 29-34 (For primary document see N93-27311 10-74)
Avail: CASI HC A02/MF A04

N93-27315*# Institute of Computational Fluid Dynamics, Tokyo (Japan).
WAVE PACKET MOTION IN HARMONIC POTENTIAL AND COMPUTER VISUALIZATION
Hideo Tsuru and Takeshi Kobayashi (Kanazawa Univ., Japan.) *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 35-40 (For primary document see N93-27311 10-74)
Avail: CASI HC A02/MF A04

N93-27317*# Johann-Wolfgang-Goethe-Univ., Frankfurt am Main (Germany).
ALTERNATIVE DESCRIPTIONS OF WAVE AND PARTICLE ASPECTS OF THE HARMONIC OSCILLATOR
Dieter Schuch *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 47-51 (For primary document see N93-27311 10-74)
Avail: CASI HC A01/MF A04

N93-27318*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
SYMMETRIES OF COUPLED HARMONIC OSCILLATORS
D. Han and Y. S. Kim (Maryland Univ., College Park.) *In its* Workshop on Harmonic Oscillators 1993 p 53-66 (For primary document see N93-27311 10-74)
Avail: CASI HC A03/MF A04

N93-27319*# Duke Univ., Durham, NC. Dept. of Physics.
THE q-HARMONIC OSCILLATORS, q-COHERENT STATES AND THE q-SYMPLECTON
L. C. Biedenharn, M. A. Lohe (Northern Territory Univ., Casuarina, Australia.), and Masao Nomura (Tokyo Univ., Japan.) *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 69-83 (For primary document see N93-27311 10-74)
(Grant NSF PHY-90-08007)
Avail: CASI HC A03/MF A04

N93-27320*# Open Univ., Milton (England).
WHICH Q-ANALOGUE OF THE SQUEEZED OSCILLATOR?
Allan I. Solomon *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 85-92 (For primary document see N93-27311 10-74)
Avail: CASI HC A02/MF A04

N93-27321*# Montreal Univ. (Quebec). Lab. of Nuclear Physics.
DEFORMATION OF SUPERSYMMETRIC AND CONFORMAL QUANTUM MECHANICS THROUGH AFFINE TRANSFORMATIONS
Vyacheslav Spiridonov *In* NASA. Goddard Space Flight Center, Workshop

on Harmonic Oscillators 1993 p 93-108 (For primary document see N93-27311 10-74)
Avail: CASI HC A03/MF A04

N93-27323*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
CONDITION FOR EQUIVALENCE OF q-DEFORMED AND ANHARMONIC OSCILLATORS
M. Artoni, Jun Zang (City Coll. of the City Univ. of New York, NY.), and Joseph L. Birman (City Coll. of the City Univ. of New York, NY.) *In its* Workshop on Harmonic Oscillators 1993 p 115-119 (For primary document see N93-27311 10-74)
Avail: CASI HC A01/MF A04

N93-27324*# State Univ. of New York, Binghamton. Dept. of Physics.
NOVEL PROPERTIES OF THE q-ANALOGUE QUANTIZED RADIATION FIELD
Charles A. Nelson *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 121-126 (For primary document see N93-27311 10-74)
(Contract DE-FG02-86ER-40291)
Avail: CASI HC A02/MF A04

N93-27327*# California Univ., Los Angeles. Dept. of Physics.
BOUNDARY CONDITIONS IN TUNNELING VIA QUANTUM HYDRODYNAMICS
Antonio B. Nassar (Harvard-Westlake School, North Hollywood, CA.) *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 149-154 (For primary document see N93-27311 10-74)
Avail: CASI HC A02/MF A04

N93-27329*# Academy of Sciences (USSR), Moscow.
SQUEEZED STATES OF DAMPED OSCILLATOR CHAIN
O. V. Manko *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 171-177 (For primary document see N93-27311 10-74)
Avail: CASI HC A02/MF A04

N93-27330*# Ferrara Univ. (Italy). Dept. of Physics.
THE UNCERTAINTY PRINCIPLE IN RESONANT GRAVITATIONAL WAVE ANTENNAE AND QUANTUM NON-DEMOLITION MEASUREMENT SCHEMES
Pierluigi Fortini, Roberto Onofrio (Padua Univ., Italy.), and Alessandro Rioli (Bologna Univ., Italy.) *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 179-194 (For primary document see N93-27311 10-74)
Avail: CASI HC A03/MF A04

N93-27332*# Iowa Univ., Iowa City. Dept. of Physics and Astronomy.
POINT FORM RELATIVISTIC QUANTUM MECHANICS AND RELATIVISTIC SU(6)
W. H. Klink *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 219-233 (For primary document see N93-27311 10-74)
Avail: CASI HC A03/MF A04

N93-27333*# Montreal Univ. (Quebec). Center of Research and Mathematics.
PHASE SPACE LOCALIZATION FOR ANTI-DE SITTER QUANTUM MECHANICS AND ITS ZERO CURVATURE LIMIT
Amine M. ElGradechi (Concordia Univ., Montreal, Quebec.) *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 235-239 (For primary document see N93-27311 10-74)
Avail: CASI HC A01/MF A04

N93-27334*# Howard Univ., Washington, DC. Dept. of Physics.
PROPER-TIME RELATIVISTIC DYNAMICS
Tepper L. Gill, W. W. Zachary, and James Lindesay *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 241-253 (For primary document see N93-27311 10-74)
Avail: CASI HC A03/MF A04

N93-27336*# Liege Univ. (Belgium). Theoretical and Mathematical Physics.
ON HARMONIC OSCILLATORS AND THEIR KEMMER RELATIVISTIC FORMS
Nathalie Debergh and Jules Beckers *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 261-265 (For primary document see N93-27311 10-74)
Avail: CASI HC A01/MF A04

N93-27337*# Universidad Nacional Autonoma de Mexico, Cuernavaca. Inst. de Ciencias Nucleares.
THE ALGEBRA OF SUPERTRACES FOR 2+1 SUPER DE SITTER GRAVITY
L. F. Urrutia, H. Waelbroeck, and F. Zertuche *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 267-272 Sponsored in part by DGAPA and ICTP (For primary document see N93-27311 10-74)
Avail: CASI HC A02/MF A04

N93-27338*# Consejo Superior de Investigaciones Cientificas, Madrid (Spain). Inst. de Optica.
QUANTUM WORMHOLES AND HARMONIC OSCILLATORS
Luis J. Garay *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 273-279 (For primary document see N93-27311 10-74)
Avail: CASI HC A02/MF A04

N93-27339*# Harvard Univ., Cambridge, MA. Lab. of Physics.
ON INDUCING FINITE DIMENSIONAL PHYSICAL FIELD REPRESENTATIONS FOR MASSLESS PARTICLES IN EVEN DIMENSIONS
Vineer Bhansali *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 281-287 (For primary document see N93-27311 10-74)
Avail: CASI HC A02/MF A04

N93-27340*# General Electric Co., Moorestown, NJ.
NONLINEAR MODES OF THE TENSOR DIRAC EQUATION AND CPT VIOLATION
Frank J. Reifler and Randall D. Morris *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 289-294 (For primary document see N93-27311 10-74)
Avail: CASI HC A02/MF A04

N93-27341*# Institute of Nuclear Physics, Krakow (Poland).
GALILEAN COVARIANT HARMONIC OSCILLATOR
Andrzej Horzela and Edward Kapuscik (Georgia Univ., Athens.) *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 295-305 Sponsored in part by the Polish State Committee for Scientific Research (For primary document see N93-27311 10-74)
Avail: CASI HC A03/MF A04

N93-27342*# Missouri Univ., Columbia. Dept. of Physics and Astronomy.
DOUBLE SIMPLE-HARMONIC-OSCILLATOR FORMULATION OF THE THERMAL EQUILIBRIUM OF A FLUID INTERACTING WITH A COHERENT SOURCE OF PHONONS
B. DeFacio, Alan VanNevel, and O. Brander (Chalmers Univ. of Technology, Goeteborg, Sweden.) *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 309-322 (For primary document see N93-27311 10-74)
(Grants AF-AFOSR-307-90; AF-AFOSR-203-91)
Avail: CASI HC A03/MF A04

N93-27343*# Leipzig Univ. (German D.R.). Dept. of Physics.
WIGNER EXPANSIONS FOR PARTITION FUNCTIONS OF NONRELATIVISTIC AND RELATIVISTIC OSCILLATOR SYSTEMS
Christian Zylka and Guenter Vojta *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 323-336 (For primary document see N93-27311 10-74)
Avail: CASI HC A03/MF A04

N93-27344*# California Univ., Berkeley. Lawrence Berkeley Lab. Dept. of Physics.
DECOHERENCE OF MULTIMODE THERMAL SQUEEZED COHERENT STATES
Leehwa Yeh *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 337-352 (For primary document see N93-27311 10-74)
(Contract DE-AC03-76SF-00098; NSF PHY-90-21139)
Avail: CASI HC A03/MF A04

N93-27345*# Food and Drug Administration, Bethesda, MD. Biophysics Lab.
QUANTUM HARMONIC OSCILLATOR IN A THERMAL BATH
Yuhong Zhang *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 353-363 (For primary document see N93-27311 10-74)
(Grant NSF PHY-87-17155)
Avail: CASI HC A03/MF A04

N93-27346*# California Univ., Berkeley. Dept. of Chemistry.
A STUDY OF ELECTRON TRANSFER USING A THREE-LEVEL SYSTEM COUPLED TO AN OHMIC BATH
Masako Takasu (Kanazawa Univ., Japan.) and David Chandler *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 365-370 Sponsored by NSF (For primary document see N93-27311 10-74)
Avail: CASI HC A02/MF A04

N93-27349*# Georgia Univ., Athens. Dept. of Physics and Astronomy.
QUANTIZED DISCRETE SPACE OSCILLATORS
C. A. Uzes and Edward Kapuscik (Institute of Nuclear Physics, Krakow, Poland.) *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 385-396 (For primary document see N93-27311 10-74)
Avail: CASI HC A03/MF A04

N93-27350*# Montreal Univ. (Quebec). Center of Researchers and Mathematics.
ORBIT-ORBIT BRANCHING RULES
F. Gingras, J. Patera, and R. T. Sharp (McGill Univ., Montreal, Quebec.) *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 397-402 Sponsored in part by the Natural Science and Engineering Research Council of Canada and by the Ministere de l'Education de Quebec (For primary document see N93-27311 10-74)
Avail: CASI HC A02/MF A04

N93-27351*# Universidad Nacional Autonoma de Mexico, Cuernavaca. Inst. de Fisica.
MASS SPECTRA OF THE PARTICLE-ANTIPARTICLE SYSTEM WITH A DIRAC OSCILLATOR INTERACTION
M. Moshinsky and G. Loyola *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 405-427 Sponsored by the Sistema Nacional de Investigadores, Mexico (For primary document see N93-27311 10-74)
Avail: CASI HC A03/MF A04

N93-27352*# Yale Univ., New Haven, CT. Center for Theoretical Physics.
FROM HARMONIC TO ANHARMONIC OSCILLATORS
F. Iachello *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 429-442 (For primary document see N93-27311 10-74)
(Contract DE-FG02-91ER-40608)
Avail: CASI HC A03/MF A04

N93-27353*# Indiana Univ., Bloomington. Dept. of Physics.
ATOMIC SUPERSYMMETRY
V. Alan Kostelecky *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 443-451 (For primary document see N93-27311 10-74)
(Contracts DE-AC02-84ER-40125; DE-FG02-91ER-40661)
Avail: CASI HC A02/MF A04

N93-27354*# Toronto Univ. (Ontario). Dept. of Physics.
THE HARMONIC OSCILLATOR AND NUCLEAR PHYSICS
D. J. Rowe *In* NASA, Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 453-468 (For primary document see N93-27311 10-74)
Avail: CASI HC A03/MF A04

N93-27355*# Pennsylvania State Univ. at Fayette, Uniontown. Dept. of Physics.
ON THE SPRING AND MASS OF THE DIRAC OSCILLATOR
James P. Crawford *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 469-474 (For primary document see N93-27311 10-74)
Avail: CASI HC A02/MF A04

N93-27356*# Institute of Nuclear Physics, Krakow (Poland).
CLASSICAL CONFINED PARTICLES
Andrzej Horzela and Edward Kapuscik (Georgia Univ., Athens.) *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 475-482 Sponsored in part by the Polish State Committee for Scientific Research (For primary document see N93-27311 10-74)
Avail: CASI HC A02/MF A04

N93-27357*# Stanford Univ., CA. Linear Accelerator Center.
SECOND QUANTIZATION IN BIT-STRING PHYSICS
H. Pierre Noyes *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 483-493 (For primary document see N93-27311 10-74)
(Contract DE-AC03-76SF-00515)
Avail: CASI HC A03/MF A04

N93-27358*# New York Univ., New York. Dept. of Radiology.
COVARIANT HARMONIC OSCILLATORS: 1973 REVISITED
M. E. Noz *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 495-510 (For primary document see N93-27311 10-74)
Avail: CASI HC A03/MF A04

N93-27359*# IIT Research Inst., Annapolis, MD.
CALCULATION OF THE NUCLEON STRUCTURE FUNCTION FROM THE NUCLEON WAVE FUNCTION
Paul E. Hussar *In* NASA. Goddard Space Flight Center, Workshop on Harmonic Oscillators 1993 p 511-523 (For primary document see N93-27311 10-74)
Avail: CASI HC A03/MF A04

80 SOCIAL SCIENCES (GENERAL)

Includes educational matters.

N93-27414# Office of Technology Assessment, Washington, DC.
EDUCATIONAL SOFTWARE MARKETPLACE AND ADULT LITERACY NICHES
20 Apr. 1992 148 p See also PB89-114276 Sponsored by Office of Technology Assessment, Washington, DC LIMITED REPRODUCIBILITY: More than 20% of this document may be affected by microfiche quality (PB93-163897) Avail: Issuing Activity (National Technical Information Service (NTIS))

The report represents an examination of the long-term viability of the adult literacy software marketplace. In an attempt to place these technology and literacy issues within a broader context, this chapter of the report examines the general market dynamics of the personal computer software industry, with a specific focus on the educational technology marketplace. This very broad perspective establishes a framework within which to examine further the adult literacy market and the use of technology within that market. It also provides some insight as to the patterns and trends that have shaped the development of other segments of the software industry and the complex interplay among those segments. NTIS

N93-27415# Claremont Graduate School, CA.
CASE STUDY OF TECHNOLOGY USE IN ADULT LITERACY PROGRAMS Final Report
J. D. Eveland, M. L. Markus, S. A. Law, D. M. Manuel, and B. Stecher Jun. 1992 200 p Sponsored by Office of Technology Assessment
(PB93-163905) Avail: CASI HC A09/MF A03

New instructional software and systems aimed at improving literacy among adults are being developed by many publishers, and the number of literacy programs that are experimenting with or actively using information technology in instruction is growing rapidly. Furthermore, computers also are finding a role in program administration. The report examines the use of such information technologies as computers and communication media (e.g., video, telephone, and computer networking), software, and educational programming in the context of current adult literacy programs. As a series of case studies, it makes no pretense to providing a complete or comprehensive picture to technology use in the context. Our introduction to the report outlines first some of the generic issues in technology use that must be taken into consideration. The authors then describe how they went about the study, and provide an overview of the sites they visited together with some of the concepts that they believe each illustrates. The six cases are followed by our summary comments and some recommendations that derive from the case data. NTIS

N93-27416# Office of Technology Assessment, Washington, DC.
SOFTWARE FOR ADULT LITERACY: SCOPE, SUITABILITY, AVAILABLE SOURCES FOR INFORMATION, AND IMPLICATIONS FOR FEDERAL POLICY Final Report
J. P. Sivin-Kachala and E. R. Bialo Jun. 1992 156 p
(PB93-163913) Avail: CASI HC A08/MF A02

The report presents an analysis of the scope of the current supply of software available for adult literacy and its suitability for a variety of adult student populations. In addition, an overview of the information sources available to adult literacy software acquisition decisionmakers is provided. Finally, the authors discuss some options for federal policy on technology for adult literacy. The report is divided into four chapters. In Chapter 1, the authors examine the distribution of the available supply of software for adult literacy with respect to subject, adult literacy sub-market, type, price, computer brand and other hardware issues, and copyright date. In Chapter 2, they assess the suitability of the existing supply of software for different adult student populations. In Chapter 3, they present an overview of sources that provider organizations consult for information about software. Finally, in Chapter 4, they offer suggestions for a government role with respect to technology for adult literacy. NTIS

N93-27420# National Center for Education Statistics, Washington, DC. Office of Educational Research and Improvement.
DIGEST OF EDUCATION STATISTICS, 1992
T. D. Snyder and J. E. Griffith Oct. 1992 522 p See also PB92-156801
(PB93-169522; NCES-92-097) Avail: CASI HC A22/MF A04

The publication contains information on a variety of subjects in the field of education statistics, including the number of schools and colleges, teachers, enrollments, and graduates, in addition to educational attainment, finances, Federal funds for education, employment and income of graduates, libraries, and international education. Supplemental information on population trends, attitudes on education, education characteristics of the labor force, government finances, and economic trends provides background for evaluating education data. NTIS

N93-27596# Research and Development Labs., Culver City, CA.
SUMMER RESEARCH PROGRAM (1992). GRADUATE STUDENT RESEARCH PROGRAM (GSRP) REPORTS. VOLUME 10: WRIGHT LABORATORY Annual Report, 1 Sep. 1991 - 31 Aug. 1992
Gary Moore 28 Dec. 1992 410 p
(Contract F49620-90-C-0076)
(AD-A262018; AFOSR-93-0120TR-Vol-10) Avail: CASI HC A18/MF A04

The following research reports were completed during the summer 1992 apprenticeship program: Point Spread Function Characterization of a Scophony Infrared Scene Projector; Fraction on the Mechanics of a Layer Composite; Velocity and Temperature Measurements in a High Swirl Dump Combustor; Development of an Enhanced Post Run Data Analysis Program for the Integrated Electromagnetic System Simulator; Hard Target Code Assessment and a Qualitative Study of Slide Line Effects in EPIC Hydrocode; Laser Imaging and Ranging (LIMAR) Processing; Neural On-Line Learning in Missile Guidance; Optimal Detection of Targets in Clutter Using an Ultra-Wideband Fully-Polarimetric SAR; Effects on Intensity Thresholding on the Power Spectrum of Laser Speckle; Using X Windows to Display Experimental Data; VLSI Synthesis Guiding Techniques Using the SOAR Artificial Intelligence Architecture. DTIC

N93-27597# Research and Development Labs., Culver City, CA.
SUMMER RESEARCH PROGRAM (1992). GRADUATE STUDENT RESEARCH PROGRAM (GSRP) REPORTS. VOLUME 11: ARNOLD ENGINEERING DEVELOPMENT CENTER, CIVIL ENGINEERING LABORATORY, FRANK J. SEILER RESEARCH LABORATORY, WILFORD HALL MEDICAL CENTER Annual Report, 1 Sep. 1991 - 31 Aug. 1992
Gary Moore 28 Dec. 1992 213 p
(Contract F49620-90-C-0076)
(AD-A262019; AFOSR-93-0121TR-Vol-11) Avail: CASI HC A10/MF A03

The following reports were completed during the Summer 1992 Apprenticeship Program: Experiences using Model-Based Techniques for the Development of a Large Parallel Instrumentation System; An Overview of the Behavior of Aluminum in Solid Propellant Rocket Motor; Solid Particulate Dispersion in Turbulent Atmospheric Boundary Layers; CAD and Acoustic BEM Applied to the Modelling of the AEDC ASTF EGMS; A Multigraph Implementation of a Distributed Image Processing System; A Cell Averaged Approach to the Solution of Integral Conservation Laws; Analysis of Acoustic Oscillations in Cavities with Spoiler Attachments; Numerical Modelling of Mixing and Reacting Flowfields; Multidimensional Conjugated Heat Transfer Analysis of the Arnold Engineering Development Center Heat-H1 Test Unit Nozzle. DTIC

N93-27598# Research and Development Labs., Culver City, CA.
SUMMER RESEARCH PROGRAM (1992). HIGH SCHOOL APPRENTICESHIP PROGRAM (HSAP) REPORTS. VOLUME 12: ARMSTRONG LABORATORY Annual Report, 1 Sep. 1991 - 31 Aug. 1992
Gary Moore 28 Dec. 1992 445 p
(Contract F49620-90-C-0076)
(AD-A262020; AFOSR-93-0122TR-Vol-12) Avail: CASI HC A19/MF A04

The following reports were among those completed during the Air Force 1992 Apprenticeship program: Cross Over Point for the Panasonic UD-716 Thermoluminescent Dosimeter Reader; The Study of Gas Chromatography: Volatile Organics; Dermal Penetration of Dibromomethane; Pathology Laboratory Overview; Dietary Intake Patterns and Cardiac Evaluations of United States Air Force Pilots. DTIC

N93-27599# Research and Development Labs., Culver City, CA.
SUMMER RESEARCH PROGRAM (1992). HIGH SCHOOL APPRENTICESHIP PROGRAM (HSAP) REPORTS. VOLUME 13: PHILLIPS LABORATORY Annual Report, 1 Sep. 1991 - 31 Aug. 1992
Gary Moore 28 Dec. 1992 295 p
(Contract F49620-90-C-0076)
(AD-A262021; AFOSR-93-0123TR-Vol-13) Avail: CASI HC A13/MF A03

The following reports were among those completed during the Air Force 1992 Apprenticeship Program: The Development of Multi-Dimensional Fourier Transform to Be Used to Predict the Light Scattering Off an Optic; Programming Bar Code Readers for Inventory Purposes Using the Interactive Reader Language; High Resolution Statistical Models for Prediction of Cloud Cover; Exploring Electromagnetic Effects; Fuzzy-C Optical Tracker; Thermal Control Using Scrapers in a Rotating-Disk, Wetted-Wall Chemical Reactor. DTIC

N93-27600# Research and Development Labs., Culver City, CA.
SUMMER RESEARCH PROGRAM (1992). HIGH SCHOOL APPRENTICESHIP PROGRAM (HSAP) REPORTS. VOLUME 14: ROME LABORATORY Annual Report, 1 Sep. 1991 - 31 Aug. 1992
Gary Moore 28 Dec. 1992 215 p
(Contract F49620-90-C-0076)
(AD-A262022; AFOSR-93-0124TR-Vol-14) Avail: CASI HC A10/MF A03

The following papers (apprenticeship reports) were completed during the 1992 Rome Laboratory summer session by high school participants: Effectiveness of Advanced Identification System and Lecroy Digitizers; Solid

Modeling Using Network II.5; The Influence of Modulation on Spectral Purity of Laser Emission; Analysis of F-16 Shielding Effectiveness; The Testing of Various Optical Logic Devices; Understanding C and UNIX Networks; Study of Crystals; Study of Crystal Growth; Programming of the C3 Backup Utility; Is Multi-Media the Answer?; Artificial Neural Systems; A Multi-Media Environment: Is It For Everyone?; Study of Parallel Distributed Processing; The Research of Different Samples Using the Scanning Electron Microscope; Laser Diode Array Testing; Advanced Radar Correlation Algorithms; Running Solid Models; Noise Measurement of Interconnecting Coaxial Cable. DTIC

N93-27601# Research and Development Labs., Culver City, CA.
SUMMER RESEARCH PROGRAM (1992). HIGH SCHOOL APPRENTICESHIP PROGRAM (HSAP) REPORTS. VOLUME 15: WRIGHT LABORATORY Annual Report, 1 Sep. 1991 - 31 Aug. 1992
Gary Moore 28 Dec. 1992 624 p
(Contract F49620-90-C-0076)
(AD-A262023; AFOSR-93-0125TR-Vol-15) Avail: CASI HC A99/MF A06

The following reports were completed in the Air Force 1992 Summer Apprenticeship program at the Wright Laboratory: An Investigation of the APTAS System; Evaluation of Hydrocode Strain Contours by Microhardness Testing; A study of the C and BASIC Computer Languages as well as an In Depth Discussion of Certain Mathematical Concepts; Electrical Analysis of YBa2Cu3O(7-x) Superconducting Thin Films and Bulk Samples; Computer Resources: Examining the Workings of a Computer Network; Forced Liquid Cooling of a Non-Flush Simulated Electronic Chip; Using Mathematical Concepts to Produce Three Dimensional Computer Graphics; Image Analysis: A Fractal Application; Analysis of Fractal Image Compression and Decompression; Video Documentation of the Patran to Epic Link; Construction and Design of a Regulated Power Supply; Preparing High Tech Aircraft for Testing; Using Computer Applications; The Creation of a Graphics Workstation; A Comparison of Concept Recognition Skills; Characterization and Analysis of 1,3,5,5-Tetranitrohexahydropyrimidine; A Study of the Importance of Sled Tests to Crew Escape Engineers. DTIC

N93-27628# Research and Development Labs., Culver City, CA.
SUMMER RESEARCH PROGRAM (1992). SUMMER FACULTY RESEARCH PROGRAM (SFRP) REPORTS. VOLUME 2: ARMSTRONG LABORATORY Annual Report, 1 Sep. 1991 - 31 Aug. 1992
Gary Moore 28 Dec. 1992 711 p
(Contract F49620-90-C-0076)
(AD-A261989; AFOSR-93-0111TR-Vol-2) Avail: CASI HC A99/MF A06

The following reports were completed during the Air Force Summer Faculty Research Program: Mathematical Modeling of the Human Cardiovascular System Under Acceleration: Analysis of the Arterial Blood Flow Using the Thick-Wall Model; An Intelligent Tutor for Sentence Combining; A Study of the Effects of Low Update Rate on Visual Displays; Development of a Research Paradigm to Study Collaboration in Multidisciplinary Design Teams; Intelligent Decision Making with Qualitative Reasoning. DTIC

N93-27629# Research and Development Labs., Culver City, CA.
SUMMER RESEARCH PROGRAM (1992). SUMMER FACULTY RESEARCH PROGRAM (SFRP) REPORTS. VOLUME 3: PHILLIPS LABORATORY Annual Report, 1 Sep. 1991 - 31 Aug. 1992
Gary Moore 28 Dec. 1992 602 p
(Contract F49620-90-C-0076)
(AD-A261990; AFOSR-93-0112TR-Vol-3) Avail: CASI HC A99/MF A06

The following reports were submitted during the 1992 Summer Faculty Research Program: Coherent Heterodyne Array Doppler Imaging; Calibration Techniques for a Low Energy X-Ray Irradiation Chamber; Ultrawideband Antennas with Low Dispersion; Optical Angle-Angle Doppler Imaging; Second-Harmonic Generation in Corona-Poled Materials. DTIC

N93-27630# Research and Development Labs., Culver City, CA.
SUMMER RESEARCH PROGRAM (1992). SUMMER FACULTY RESEARCH PROGRAM (SFRP) REPORTS. VOLUME 4: ROME LABORATORY Annual Report, 1 Sep. 1991 - 31 Aug. 1992
Gary Moore 28 Dec. 1992 246 p
(Contract F49620-90-C-0076)
(AD-A261991; AFOSR-93-0113TR-Vol-4) Avail: CASI HC A11/MF A03

The following reports were a part of those completed during the Air Force 1992 Summer Research Program: Toward the Development of a Generalized Method and Code for Analyzing Infinite Arrays of Antennas Printed on Both Sides of Protruding Dielectric Substrates; Statistical Comparison of Several Automatic Target Recognition (ATR) Systems; Photonics Technology Development at Rome Laboratory; Atomistic Simulation of Grains in Submicron Aluminum Interconnects; Measurement of Thermophysical Properties of Semiconductors at High Temperature; Photonic Delay Line for High-Frequency Radar Systems; User-Based Requirements for Large-Scale Distributed Information Management Systems: Representation for System Designers; Flux Creep in a Y-Ba-Cu-O Film Characterized by a C-Axis Microstructure Imbedded with A-Axis Oriented Grains. DTIC

N93-27631# Research and Development Labs., Culver City, CA.
SUMMER RESEARCH PROGRAM (1992). SUMMER FACULTY RESEARCH PROGRAM (SFRP) REPORTS. VOLUME 5A: WRIGHT LABORATORY Annual Report, 1 Sep. 1991 - 31 Aug. 1992
Gary Moore 28 Dec. 1992 483 p
(Contract F49620-90-C-0076)
(AD-A261992; AFOSR-93-0114TR-Vol-5A) Avail: CASI HC A21/MF A04

The purpose of this program is to develop the basis for continuing research of interest to the Air Force at the institution of the faculty member; to stimulate continuing relations among faculty members and professional peers in the Air Force to enhance the research interests and capabilities of scientific and engineering educators; and to provide follow-on funding for research of particular promise that was started at an Air Force laboratory under the Summer Faculty Research Program. During the summer of 1992 185 university faculty conducted research at Air Force laboratories for a period of 10 weeks. Each participant provided a report of their research, and these reports are consolidated into this annual report. DTIC

N93-27632# Research and Development Labs., Culver City, CA.
SUMMER RESEARCH PROGRAM (1992). SUMMER FACULTY RESEARCH PROGRAM (SFRP) REPORTS. VOLUME 5B: WRIGHT LABORATORY Annual Report, 1 Sep. 1991 - 31 Aug. 1992
Gary Moore 28 Dec. 1992 427 p
(Contract F49620-90-C-0076)
(AD-A261993; AFOSR-93-0115TR-Vol-5B) Avail: CASI HC A19/MF A04

The following topics were among those completed during the Summer 1992 Apprenticeship program: Validation of a Hypersonic Nonequilibrium Code for Nozzle Flow; Motion Segmented Object Identification Using 1-D Signal Analysis and a Heteroassociative Complex Neural Network; Analytical Guidance Laws and Integrated Guidance/Autopilot for Homing Missiles; Estimation of Aspect Angles of Targets in FLIR Images; Crack Arrest in Composite Plates Reinforced with Tough Layers; Some Results in Machine-Learning; Effect of Antioxidants on Thermal Decomposition of Energetic Materials. DTIC

N93-27633# Research and Development Labs., Culver City, CA.
SUMMER RESEARCH PROGRAM (1992). SUMMER FACULTY RESEARCH PROGRAM (SFRP) REPORTS. VOLUME 6: ARNOLD ENGINEERING DEVELOPMENT CENTER, CIVIL ENGINEERING LABORATORY, FRANK J. SEILER RESEARCH LABORATORY, WILFORD HALL MEDICAL CENTER Annual Report, 1 Sep. 1991 - 31 Aug. 1992
Gary Moore 28 Dec. 1992 425 p
(Contract F49620-90-C-0076)
(AD-A261994; AFOSR-93-0116TR-Vol-6) Avail: CASI HC A18/MF A04

The following topics were among those completed at the Air Force Faculty Research Summer Program: Experiences Using Model-Based Techniques for the Development of a Large Parallel Instrumentation System; Data Reduction of Laser Induced Fluorescence in Rocket Motor Exhausts; Feasibility of Wavelet Analysis for Plume Data Study; Characterization of Seagrass Meadows in St. Andrew (Crooked Island) Sound, Northern Gulf of Mexico; A Preliminary Study of the Weathering of Jet Fuels in Soil Monitored by SFE with GC Analysis; Preliminary Numerical model of Groundwater Flow at the MADE2 Site. DTIC

N93-27634# Research and Development Labs., Culver City, CA.
SUMMER RESEARCH PROGRAM (1992). GRADUATE STUDENT RESEARCH PROGRAM (GSRP) REPORTS. VOLUME 9: ROME LABORATORY Annual Report, 1 Sep. 1991 - 31 Aug. 1992
Gary Moore 28 Dec. 1992 137 p
(Contract F49620-90-C-0076)
(AD-A262017; AFOSR-93-0119TR-Vol-9) Avail: CASI HC A07/MF A02

The following reports were completed during the 1992 Air Force Summer Program: Photonic Transversal Filtering of Microwave Systems; Implementation of the ITT Multiple Parameter Speaker Recognition Algorithm on the Sun Sparc; Mathematical Description, Computer Simulation and Analysis of a Pointing, Acquisition and Tracking System for Optical Intersatellite Crosslinks; Congestion Control for ATM Networks in a Tactical Theater Environment. DTIC

N93-27642# Research and Development Labs., Culver City, CA.
SUMMER RESEARCH PROGRAM (1992). GRADUATE STUDENT RESEARCH PROGRAM (GSRP) REPORTS. VOLUME 8: PHILLIPS LABORATORY Annual Report, 1 Sep. 1991 - 31 Aug. 1992
Gary Moore 28 Dec. 1992 271 p LIMITED REPRODUCIBILITY: More than 20% of this document may be affected by microfiche quality
(Contract F49620-90-C-0076)
(AD-A261972; AFOSR-93-0118TR-Vol-8) Avail: CASI HC A12

The following reports were completed during the Air Force 1992 Graduate Research Program: experimental investigation of homogeneous and heterogeneous nucleation/condensation processes and products in coil; ion-molecule reactions at high temperatures; optical and atmospheric turbulence; Lagrangian formulation of Lageos's spin dynamics; a study of coupled oscillatory neural network models; high temperature heat pipe modeling under low power heat loads and cryogenic phase change material devices in space applications. DTIC

N93-28223# Research and Development Labs., Culver City, CA.
SUMMER RESEARCH PROGRAM (1992). GRADUATE STUDENT Annual Report, 1 Sep. 1991 - 31 Aug. 1992
Gary Moore 28 Dec. 1992 257 p
(Contract F49620-90-C-0076)
(AD-A261971; AFOSR-93-0117TR) Avail: CASI HC A12/MF A03

The purpose of this program is to develop the basis for continuing research of interest to the Air Force at the institution of the faculty member; to stimulate continuing relations among faculty members and professional peers in the Air Force to enhance the research interests and capabilities of scientific and engineering educators; and to provide the follow-on funding for research of particular promise that was started at an Air Force laboratory under the Summer Faculty Research Program. During the summer of 1992, 185 university faculty conducted research at Air Force laboratories for a period of 10 weeks. Each participant provided a report of their research, and these reports are consolidated into this annual report. DTIC

81 ADMINISTRATION AND MANAGEMENT

Includes management planning and research.

N93-27028*# National Aeronautics and Space Administration, Washington, DC.
NASA SBIR PRODUCT CATALOG, 1990
F. Carl Schwenk (Futron Corp., Bethesda, MD.) and J. A. Gilman (Futron Corp., Bethesda, MD.) 1990 32 p
(NASA-TM-105103; NASA-SBIR-PC-90; NAS 1.15:105103) Copyright Avail: CASI HC A03/MF A01

Since 1983 the NASA Small Business Innovation Research (SBIR) program has benefitted both the agency and the high technology small business community. By making it possible for more small businesses to participate in NASA's research and development, SBIR also provides opportunities for these entrepreneurs to develop products which may also have significant commercial markets. Structured in three phases, the SBIR program uses Phase 1 to assess the technical feasibility of novel ideas proposed by small companies and Phase 2 to conduct research and development on the best concepts. Phase 3, not funded by SBIR, is the utilization and/or commercialization phase. A partial list of products of NASA SBIR projects which have advanced to some degree into Phase 3 are provided with a brief description. Derived from text

N93-27280# Technische Univ., Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
EXTENSIONS OF CHOICE BEHAVIOUR
Ton J. A. Storcken (Tilburg Univ., Netherlands.) and Pieter H. M. Ruys (Tilburg Univ., Netherlands.) Jun. 1992 28 p
(MEMO-COSOR-92-23; ETN-93-93179) Avail: CASI HC A03/MF A01

An axiomatic foundation of revealed preference theory is obtained by formulating conditions on the mapping from the space of choice functions into the space of preference relations. Dual conditions are applied on the inverse or dual mapping. The composition of both maps is shown to be an extension of the choice function. Both the unique preference relation and the unique decision rule endogeneously determined by the extended choice function are derived. The decision rule turns out to select weakly undominated alternatives. A slightly stronger assumption in the choice function results in the well known revelation theorems, which are based upon choosing the best alternatives. ESA

N93-27384# Technische Univ., Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
LOCAL SEARCH IN PHYSICAL DISTRIBUTION MANAGEMENT
G. A. P. Kindervater (Erasmus Univ., Rotterdam, Netherlands.) and M. W. P. Savelsbergh Aug. 1992 26 p
(Memo-COSOR-92-30; ETN-93-93186) Avail: CASI HC A03/MF A01

Some of the resulting vehicle routing and sheduling models are discussed. Physical distribution management presents a variety of decision making problems at the three levels of strategic, tactical and operational planning. Physical distribution management at the operational level, responsible for an important fraction of the total distribution costs, is considered. The paper is organized as follows: a survey of various methods proposed to implement K-exchange methods for constrained variants of the traveling salesman problem efficiently; and a demonstraton of how these methods can be used in a situation with multiple routes. ESA

N93-27490# Universiteit Twente, Enschede (Netherlands). Tele-Informatics and Open Systems Group.
LOTOSPHERE, AN ATTEMPT TOWARDS A DESIGN CULTURE
Chris A. Vissers, Luis FerreiraPires, and Jeroen vandeLagemaat 12 Aug. 1992 34 p
(Memo-INF-92-56; TIOS-92-24; ETN-93-93209) Copyright Avail: CASI HC A03/MF A01

A number of different, but strongly related, elements that determine the design environment in industrial companies and are key factors in productivity and product quality are discussed. If such elements are properly recognized, commonly accepted, and carefully maintained by an industrial company and determine the skills and way of operation of the designers, they determine the typical design culture of that company. The ESPRIT 2 Lotosphere project tried to contribute to the improvement of productivity and product quality and the enrichment of public and private design cultures by discussing the objectives and results of Lotosphere in the light of these elements. The paper is structured as follows: analysis of the elements of a design culture, their relationships and multidependencies; description of the objectives and structures of the Lotosphere project; and presentation of the activities and achievements of Lotosphere to the elements of a design culture. ESA

N93-27591*# National Aeronautics and Space Administration, Washington, DC.
NASA SBIR PRODUCT CATALOG, 1991
1991 63 p
(NASA-TM-108080; NAS 1.15:108080; NASA-SBIR-PC-91) Avail: CASI HC A04/MF A01

This catalog is a partial list of products of NASA SBIR (Small Business Innovation Research) projects that have advanced to some degree into Phase 3. While most of the products evolved from work conducted during SBIR Phase 1 and 2, a few advanced to commercial status solely from Phase 1 activities. The catalog presents information provided to NASA by SBIR contractors who wished to have their products exhibited at Technology 2001, a NASA-sponsored technology transfer conference held in San Jose, California, on December 4, 5, and 6, 1991. The catalog presents the

product information in the following technology areas: computer and communication systems; information processing and AI; robotics and automation; signal and image processing; microelectronics; electronic devices and equipment; microwave electronic devices; optical devices and lasers; advanced materials; materials processing; materials testing and NDE; materials instrumentation; aerodynamics and aircraft; fluid mechanics and measurement; heat transfer devices; refrigeration and cryogenics; energy conversion devices; oceanographic instruments; atmosphere monitoring devices; water management; life science instruments; and spacecraft electromechanical systems. Derived from text

N93-27639*# National Aeronautics and Space Administration, Washington, DC.
NASA SMALL BUSINESS INNOVATION RESEARCH PROGRAM. COMPOSITE LIST OF PROJECTS, 1983 TO 1989
Aug. 1990 130 p
(NASA-TM-104991; NASA-SBIR-CL-90; NAS 1.15:104991) Avail: CASI HC A07/MF A02

The NASA SBIR Composite List of Projects, 1983 to 1989, includes all projects that have been selected for support by the Small Business Innovation Research (SBIR) Program of NASA. The list describes 1232 Phase 1 and 510 Phase 2 contracts that had been awarded or were in negotiation for award in August 1990. The main body is organized alphabetically by name of the small businesses. Four indexes cross-reference the list. The objective of this listing is to provide information about the SBIR program to anyone concerned with NASA research and development activities. Derived from text

N93-27828# Industrial Coll. of the Armed Forces, Washington, DC.
BUREAUCRACIES AT WAR: THE V-22 OSPREY PROGRAM
Dean G. Sedivy Apr. 1992 71 p
(AD-A262451; NDU-ICAF-92-F37) Avail: CASI HC A04/MF A01

The V-22 Osprey has been the focus of growing conflicts between the Administration, Congress, the military services, and the aerospace industry. Since 1989, attempts by the Secretary of Defense to cancel the program have been blocked by congressional action. The paper examines the program's origins and the development of bureaucratic tactics and alliances used to exert control over the program's future. A final review shows the significance of a changing budgetary climate on the nation's defense acquisition process, and how it affects procurement strategy, political compromise, and enhancement of national security. DTIC

N93-27937# Technische Univ., Delft (Netherlands).
BUSINESS REENGINEERING IN INFORMATION INTENSIVE ORGANIZATIONS Ph.D. Thesis
Remko Cornelis Johan Dur 1992 266 p Sponsored by Technology Labor and Organization Program, Netherlands
(ISBN-90-9005061-2; ETN-93-93616) Copyright Avail: CASI HC A12/MF A03

An approach which supports those involved in the process of organizational change, a process for which the term business reengineering is introduced, is presented. The approach emphasizes the need for an analysis of problems and opportunities based on a detailed description of the current organization. Within the approach the evaluation of the effect of different change options is supported by means of a dynamic modeling technique. Using this technique, current and future business processes can be simulated. By comparing the two a clear understanding is obtained of the impact of proposed changes on the effectiveness of the organization, as well as on the working environment of all those involved. Case studies concerning a governmental department, an insurance firm, and a municipal department, are given. ESA

N93-28297# Oak Ridge Associated Universities, Inc., TN.
THIRD ANNUAL WOMEN IN SCIENCE AND TECHNOLOGY CONFERENCE
1992 11 p Conference held in Oak Ridge, TN, 5-6 Mar. 1992 Prepared in cooperation with Oak Ridge National Lab., TN
(Contracts DE-AC05-76OR-00033; DE-AC05-84OR-21400)
(DE93-005271; CONF-9203215-1) Avail: CASI HC A03/MF A01

This report presents discussions presented at the conference for women in science and technology. Topics include balancing careers with the family, choices concerning graduate schools, and sexual harassment. DOE

82 DOCUMENTATION AND INFORMATION SCIENCE

Includes information management; information storage and retrieval technology; technical writing; graphic arts; and micrography.

For computer documentation see *61 Computer Programming and Software.*

N93-26900*# NASA Center for AeroSpace Information, Baltimore-Washington International Airport, MD.
ACRONYM DICTIONARY
Washington Jun. 1993 259 p
(Contract NASw-4584)
(NASA-CR-193218; NAS 1.26:193218) Avail: CASI HC A12/MF A03

This reference was originally compiled as a tool for abstracters who need to know the expansion of acronyms they may encounter in the texts they are analyzing. It is a general rule of abstracting at the NASA Center For Aerospace Information (CASI) that acronyms are expanded in the abstract to enhance both information content and searchability. Over the last 22 years, abstracters at CASI have recorded acronyms and their expansions as they were encountered in documents. This is therefore an ad-hoc reference, rather than a systematic collection of all acronyms related to aerospace science and technology. CASI

N93-26901*# RMS Associates, Linthicum Heights, MD.
MACHINE AIDED INDEXING FROM NATURAL LANGUAGE TEXT Status Report, 2 Nov. 1981 - 31 Oct. 1992
June P. Silvester, Michael T. Genuardi, and Paul H. Klingbiel Mar. 1993 86 p
(Contracts NASw-4584; NASw-4070; NASw-3330)
(NASA-CR-4512; NAS 1.26:4512) Avail: CASI HC A05/MF A01

The NASA Lexical Dictionary (NLD) Machine Aided Indexing (MAI) system was designed to (1) reuse the indexing of the Defense Technical Information Center (DTIC); (2) reuse the indexing of the Department of Energy (DOE); and (3) reduce the time required for original indexing. This was done by automatically generating appropriate NASA thesaurus terms from either the other agency's index terms, or, for original indexing, from document titles and abstracts. The NASA STI Program staff devised two different ways to generate thesaurus terms from text. The first group of programs identified noun phrases by a parsing method that allowed for conjunctions and certain prepositions, on the assumption that indexable concepts are found in such phrases. Results were not always satisfactory, and it was noted that indexable concepts often occurred outside of noun phrases. The first method also proved to be too slow for the ultimate goal of interactive (online) MAI. The second group of programs used the knowledge base (KB), word proximity, and frequency of word and phrase occurrence to identify indexable concepts. Both methods are described and illustrated. Online MAI has been achieved, as well as several spinoff benefits, which are also described. Author

N93-26902*# NASA Center for AeroSpace Information, Baltimore-Washington International Airport, MD.
KNOWLEDGE-BASED MACHINE INDEXING FROM NATURAL LANGUAGE TEXT: KNOWLEDGE BASE DESIGN, DEVELOPMENT, AND MAINTENANCE
Michael T. Genuardi Washington Mar. 1993 8 p Presented at the Second International Congress on Terminology and Knowledge Engineering, Trier, Germany, 2-4 Oct. 1990
(Contract NASw-4070)
(NASA-CR-4523; NAS 1.26:4523) Avail: CASI HC A02/MF A01

One strategy for machine-aided indexing (MAI) is to provide a concept-level analysis of the textual elements of documents or document abstracts. In such systems, natural-language phrases are analyzed in order to identify and classify concepts related to a particular subject domain. The overall performance of these MAI systems is largely dependent on the quality and comprehensiveness of their knowledge bases. These knowledge bases function to (1) define the relations between a controlled indexing vocabulary and natural language expressions; (2) provide a simple mechanism for disambiguation and the determination of relevancy; and (3) allow the extension of concept-hierarchical structural to all elements of the knowledge file. After a brief description of the NASA Machine-Aided Indexing

system, concerns related to the development and maintenance of MAI knowledge bases are discussed. Particular emphasis is given to statistically-based text analysis tools designed to aid the knowledge base developer. One such tool, the Knowledge Base Building (KBB) program, presents the domain expert with a well-filtered list of synonyms and conceptually-related phrases for each thesaurus concept. Another tool, the Knowledge Base Maintenance (KBM) program, functions to identify areas of the knowledge base affected by changes in the conceptual domain (for example, the addition of a new thesaurus term). An alternate use of the KBM as an aid in thesaurus construction is also discussed. Author

N93-27042*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
WORKSHOP PROCEEDINGS: INFORMATION SYSTEMS FOR SPACE ASTROPHYSICS IN THE 21ST CENTURY, VOLUME 1
James Cutts, ed. and Edward Ng, ed. 1 May 1991 116 p Workshop held in Annapolis, MD, 23-25 May 1990 Astrotech 21 Series 3: Integrated Technology Planning
(Contract NAS7-918)
(NASA-CR-192825; JPL-Publ-91-24-Vol-1; NAS 1.26:192825) Avail: CASI HC A06/MF A02

The Astrophysical Information Systems Workshop was one of the three Integrated Technology Planning workshops. Its objectives were to develop an understanding of future mission requirements for information systems, the potential role of technology in meeting these requirements, and the areas in which NASA investment might have the greatest impact. Workshop participants were briefed on the astrophysical mission set with an emphasis on those missions that drive information systems technology, the existing NASA space-science operations infrastructure, and the ongoing and planned NASA information systems technology programs. Program plans and recommendations were prepared in five technical areas: Mission Planning and Operations; Space-Borne Data Processing; Space-to-Earth Communications; Science Data Systems; and Data Analysis, Integration, and Visualization. For individual titles, see N93-27043 through N93-27047.

N93-27043*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
ASTROTECH 21: A TECHNOLOGY PROGRAM FOR FUTURE ASTROPHYSICS MISSIONS **c12**
James A. Cutts and George P. Newton (National Aeronautics and Space Administration, Washington, DC.) *In its* Workshop Proceedings: Information Systems for Space Astrophysics in the 21st Century, Volume 1 1 May 1991 p 3-16 (For primary document see N93-27042 10-82)
Avail: CASI HC A03/MF A02

The Astrotech 21 technology program is being formulated to enable a program of advanced astrophysical observatories in the first decade of the 21st century. This paper describes the objectives of Astrotech 21 and the process that NASA is using to plan and implement it. It also describes the future astrophysical mission concepts that have been defined for the twenty-first century and discusses some of the requirements that they will impose on information systems for space astrophysics. Author

N93-27044*# National Aeronautics and Space Administration, Washington, DC.
ASTROPHYSICS SCIENCE OPERATIONS IN THE GREAT OBSERVATORIES ERA
Guenter R. Riegler *In* JPL, Workshop Proceedings: Information Systems for Space Astrophysics in the 21st Century, Volume 1 1 May 1991 p 17-24 (For primary document see N93-27042 10-82)
Avail: CASI HC A02/MF A02

Plans for Astrophysics science operations during the decade of the nineties are described from the point of view of a scientist who wishes to make a space-borne astronomical observation or to use archival astronomical data. 'Science Operations' include the following: proposal preparation, observation planning and execution, data collection, data processing and analysis, and dissemination of results. For each of these areas of science operations, we derive technology requirements for the next ten to twenty years. The scientist will be able to use a variety of services and infrastructure, including the 'Astrophysics Data System.' The current status and plans for these science operations services are described. Author (revised)

N93-27045*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
INFORMATION TECHNOLOGIES FOR ASTROPHYSICS CIRCA 2001
Peter J. Denning *In* JPL, Workshop Proceedings: Information Systems for Space Astrophysics in the 21st Century, Volume 1 1 May 1991 p 25-41 Previously announced as N92-11936 (For primary document see N93-27042 10-82)
Avail: CASI HC A03/MF A02

It is easy to extrapolate current trends to see where technologies relating to information systems in astrophysics and other disciplines will be by the end of the decade. These technologies include miniaturization, multiprocessing, software technology, networking, databases, graphics, pattern computation, and interdisciplinary studies. It is less easy to see what limits our current paradigms place on our thinking about technologies that will allow us to understand the laws governing very large systems about which we have large data sets. Three limiting paradigms are as follows: saving all the bits collected by instruments or generated by supercomputers; obtaining technology for information compression, storage, and retrieval off the shelf; and the linear model of innovation. We must extend these paradigms to meet our goals for information technology at the end of the decade. Author (revised)

N93-27046*# National Aeronautics and Space Administration, Washington, DC.
NASA'S INFORMATION TECHNOLOGY ACTIVITIES FOR THE 90'S
Lee Holcomb and Dan Erickson (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) *In* JPL, Workshop Proceedings: Information Systems for Space Astrophysics in the 21st Century, Volume 1 1 May 1991 p 43-47 (For primary document see N93-27042 10-82)
Avail: CASI HC A01/MF A02

The Office of Aeronautics, Exploration and Technology (OAET) is completing an extensive assessment of its nearly five hundred million dollars of proposed space technology development work. The budget is divided into four segments which are as follows: (1) the base research and technology program; (2) the Civil Space Technology Initiative (CSTI); (3) the Exploration Technology Program (ETP); and (4) the High Performance Computing Initiative (HPCI). The programs are briefly discussed in the context of Astrotech 21. Derived from text

N93-27047*# Space Telescope Science Inst., Baltimore, MD.
WHITE PAPER ON SCIENCE OPERATIONS
Ethan J. Schreier *In* JPL, Workshop Proceedings: Information Systems for Space Astrophysics in the 21st Century, Volume 1 1 May 1991 p 49-61 (For primary document see N93-27042 10-82)
Avail: CASI HC A03/MF A02

Major changes are taking place in the way astronomy gets done. There are continuing advances in observational capabilities across the frequency spectrum, involving both ground-based and space-based facilities. There is also very rapid evolution of relevant computing and data management technologies. However, although the new technologies are filtering in to the astronomy community, and astronomers are looking at their computing needs in new ways, there is little coordination or coherent policy. Furthermore, although there is great awareness of the evolving technologies in the arena of operations, much of the existing operations infrastructure is ill-suited to take advantage of them. Astronomy, especially space astronomy, has often been at the cutting edge of computer use in data reduction and image analysis, but has been somewhat removed from advanced applications in operations, which have tended to be implemented by industry rather than by the end-user scientists. The purpose of this paper is threefold. First, we briefly review the background and general status of astronomy-related computing. Second, we make recommendations in three areas: data analysis; operations (directed primarily to NASA-related activities); and issues of management and policy, believing that these must be addressed to enable technological progress and to proceed through the next decade. Finally, we recommend specific NASA-related work as part of the Astrotech-21 plans, to enable better science operations in the operations of the Great Observatories and in the lunar outpost era.
Author (revised)

N93-27242# Technische Univ., Eindhoven (Netherlands). Dept. of Electrical Engineering.
EMDABS: DESIGN AND FORMAL SPECIFICATION OF A DATAMODEL FOR A CLINICAL RESEARCH DATABASE SYSTEM M.S. Thesis
F. M. Pfaffenhoefer, P. J. M. Cluitmans, and H. M. Kuipers Jan. 1991

107 p
(EUT-91-E-250; ISBN-9-06-144250-8; ETN-93-93155) Avail: CASI HC A06/MF A02

A clinical research data base system called EMDABS (Electrophysiologic Monitoring Data Base System) designed to store data collected during neuro-electrophysiologic monitoring sessions, was developed. The data base system was developed for servo-anesthesia research and will be useful for other neuro-electrophysiologic research. A data model of this data base system is needed to specify what information will be stored in the data base, what data structures exist, and which constraints (semantics) are forced on the data. A partial data model was developed that left the time related information collected during a monitoring session unspecified. The development of a time related data model which is highly flexible and contains all the time related information needed such as equipment settings, information on collected raw data, data derived from raw data, and events that took place during a monitoring session is described. The formal specification of the total data model is presented. ESA

N93-27419# Transportation Research Board, Washington, DC.
TRANSPORTATION PLANNING, PROGRAMMING, LAND USE, AND APPLICATIONS OF GEOGRAPHIC INFORMATION SYSTEMS
Transportation Research Record
1992 210 p See also PB85-120145
(PB93-167815; TRB/TRR-1364) Avail: CASI HC A10/MF A03

Some of the topics discussed are as follows: Use of Highway Performance Monitoring System in Reclassifying Rural Highways in Support of National Highway System in Kansas; Planning for Texas's Needs Using Highway Performance Monitoring System Analytical Process; Transportation Network Design Using a Cumulative Genetic Algorithm and Neural Network; Diffusion of Transportation Planning Applications in Metropolitan Planning Organization: Results of National Survey; Decentralization of Jobs and Emerging Suburban Commute; Geographic Information System-Based Transportation Program Management System for County Transportation Agency; Analysis of Transit Service Areas Using Geographic Information Systems; Matching Planning Styles and Roles in Transportation to Conditions of Uncertainty and State Technological Know-How; Phoenix Commercial Vehicle Survey and Travel Models; Proposed Method for Calibrating Weigh-in-Motion Systems and for Monitoring that Calibration Over Time; Applications of Weigh-in-Motion Data in Transportation Planning; and Trial Implementation of a Photoelectric Sensor System to Classify Vehicles. NTIS

N93-27426*# National Aeronautics and Space Administration, Washington, DC.
THE NASA SCIENTIFIC AND TECHNICAL INFORMATION PROGRAM: EXPLORING CHALLENGES, CREATING OPPORTUNITIES
Ronald P. Septic May 1993 58 p Original contains color illustrations
(NASA-SP-7103; NAS 1.21:7103) Avail: CASI HC A04/MF A01; 27 functional color pages

The NASA Scientific and Technical Information (STI) Program offers researchers access to the world's largest collection of aerospace information. An overview of Program activities, products and services, and new directions is presented. The R&D information cycle is outlined and specific examples of the NASA STI Program in practice are given. Domestic and international operations and technology transfer activities are reviewed and an agenda for the STI Program NASA-wide is presented. Finally, the incorporation of Total Quality Management and evaluation metrics into the STI Program is discussed. CASI

N93-27494# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
TOWARDS A DESIGN THEORY FOR DATABASE TRIGGERS
A. P. J. M. Siebes, M. H. vanderVoort, and M. L. Kersten Jan. 1992 20 p Sponsored by Netherlands Organization for Applied Scientific Research
(CWI-CS-R9201; ETN-93-93214) Copyright Avail: CASI HC A03/MF A01

A framework for the formalism of data base triggers is presented. The parameters of trigger execution and the options for their setting are identified. This includes the execution of a single trigger, the execution of multiple triggers (priority functions), and the integration of triggers with transactions (nested triggers). The formalization framework is a step towards the development of a firmly based trigger design theory. Such a theory is needed to guide the development of well behaving applications. The development of a trigger design theory is initiated with the formulation of a sufficient condition for trigger independence. Development of a complete design theory requires solutions to issues not covered yet. Furthermore, a thorough study of nested triggers and their semantics is needed to fully formalize the integration of triggers with user initiated actions. ESA

N93-27503 Indiana Univ., Bloomington.
THE PERFORMANCE OF CITED REFERENCES AS AN APPROACH TO INFORMATION RETRIEVAL Ph.D. Thesis
Lanju Lee Yoon 1992 292 p
Avail: Univ. Microfilms Order No. DA9310395

Databases publicly available for online searching permit both citation and subject searching, however, subject searching has dominated the online search environment. Despite the power of citation searching it may be underutilized. This study explored the relationship between information retrieval effectiveness and the number of cited references used in a citation search, a relatively unstudied phenomenon. Three articles in the library and information science literature were chosen to represent sample questions. Cited reference searches were conducted for each article and each of its references. All searches were conducted in SOCIAL SCISEARCH and SCISEARCH on DIALOG. Relevance judgments on the retrieved citations were obtained from the authors of the original articles. This research focused on analyzing, in terms of information retrieval effectiveness, the overlap among postings sets retrieved by various combinations of cited references. The findings from the three case studies clearly showed that the more cited references used for the citation search, the better the performance, in terms of retrieving more relevant documents, up to a point of diminishing returns. In addition, generally the overall level of overlap among relevant documents sets was found to be low. Therefore, if only some of the cited references among many candidates are used for a citation search, a significant proportion of relevant documents may be missed. The findings of this comprehensive exploratory study are of interest for both theoretical and practical reasons. They contribute to the development of a theoretical model for the effective use of the citation search. This model might also be implemented in operational online systems. In addition, the findings potentially will help online searchers improve their search strategies using the citation search so that they can better achieve their information retrieval goals: the retrieval of items relevant to a given question and the suppression of nonrelevant items. Dissert. Abstr.

N93-27605# Defense Technical Information Center, Alexandria, VA.
HANDBOOK FOR USERS Final Report
Bonnie G. Klein Feb. 1993 205 p Supersedes DTICH-4185.1
(AD-A260738; DTIC/TR-93-9) Avail: CASI HC A10/MF A03

This handbook is your guide to the Defense Technical Information Center (DTIC). It describes DTIC's products and services and provides users step by step instructions for completing all basic DTIC transactions such as registering for general and network services, and ordering and submitting technical reports. To assist the user, it includes examples of the required forms and several appendices containing commonly used abbreviations, telephone numbers and DTIC prices. Author (revised)

N93-27881# Technische Univ., Delft (Netherlands).
DATA COMPRESSION TECHNIQUES FOR DIGITAL VIDEO RECORDING Ph.D. Thesis
Peter Hendrik Nelis deWith 1992 307 p
(ETN-93-93610) Avail: CASI HC A14/MF A03

An overview of investigations on compression techniques for experimental digital video recorders of the last decade, which also reviewed HDTV (High Definition Television) consumer recording, electronic still picture storage, and low rate multimedia applications, is presented. An intraframe Discrete Cosine Transform (DCT) coding system for compressing standard resolution YUV component TV signals with a factor of 4 to 6 to a bit rate of 20 to 25 Mbit/s is described. This architecture was employed successfully in an experimental digital recording system. Measures for enhancing the system robustness for both errors and during the trick modes are investigated. Bit rate reduction and recording of HDTV signals for consumer applications was studied in two ways: a gradual introduction of HDTV recording based on already existing digital TV recorders; and HDTV recording with TV recording features on the same (small) recording mechanics. In such a system, HDTV signals can be independently coded from the TV

signals, but they need to be more compressed than TV signals, because feasible recording mechanics allow only for the double or triple bit rate used for TV signals. The additional bit rate reduction was obtained by applying motion compensated DCT coding every second video frame. This technique was combined with intraframe DCT coding in every first frame, thereby creating a feasible system which still allows for editing and trick modes on two frame basis, and which offers a compressed HDTV bit rate around 50 Mbit/s. ESA

N93-27886# Nijmegen Univ. (Netherlands). Dept. of Informatics.
EVOLVING INFORMATION SYSTEMS: BEYOND TEMPORAL INFORMATION SYSTEMS
E. D. Falkenberg, J. L. H. Oei, and H. A. Proper 21 Feb. 1992 15 p
Sponsored by Netherlands Organization for Scientific Research
(TR-92-04; ETN-93-93139) Avail: CASI HC A03/MF A01

The need for information systems which are capable of evolving to the same extent as organizations do is discussed. Requirements of evolving organizations on their information systems are identified, and this is followed by alternative approaches to adequate information systems development life cycles. An evolutionary approach which results in so called evolving information systems is adopted. On the basis of requirements and an architecture for these evolving information systems, the distinction from traditional information systems is explained. Traditional information systems, including temporal information systems, appear to be degenerations of our evolving informations systems. A conceptual framework for update on evolving information systems is derived from the requirements. An event level, a recording level, and a correction level are distinguished in this framework for update. ESA

N93-27887# Nijmegen Univ. (Netherlands). Dept. of Informatics.
A META MODEL FOR UPDATE IN EVOLVING INFORMATION SYSTEMS
E. D. Falkenberg, J. L. H. Oei, and H. A. Proper 21 Feb. 1992 17 p
Sponsored by Netherlands Organization for Scientific Research
(TR-92-05; ETN-93-93140) Avail: CASI HC A03/MF A01

The presentation focuses on evolving information systems. An evolving information system supports the information needs of an evolving organization. Such a system is able to adapt itself instantaneously to the changes of the supported organization, such that there is no need to interrupt the activities of the organization. Furthermore, evolving information systems support changes of all time and application dependent aspects, such as the database as well as the schema of the application. A framework for the processing of updates in evolving information systems is presented. In this framework, an update is regarded as recording, correction, or forgetting, and state transitions are considered on three different levels of abstraction: the event level, the recording level, and the correction level. A formal specification of this framework is provided. ESA

N93-27915# Nijmegen Univ. (Netherlands). Dept. of Informatics.
INDEX EXPRESSION BELIEF NETWORKS FOR INFORMATION DISCLOSURE
P. D. Bruza and L. C. vanderGaag (Utrecht State Univ., Netherlands.) 2 Apr. 1992 25 p Sponsored in part by EEC/ESPRIT
(TR-92-12; ETN-93-93144) Avail: CASI HC A03/MF A01

The incorporation of semantics into the retrieval mechanism to extend the effectiveness of information disclosure is addressed. A promising mechanism for information disclosure, called the Refinement Machine, is described. The Refinement Machine features the language of index expressions as a language for characterizing information objects and a deduction mechanism driven by rules of inference. Two types of inference rules are distinguished. The rules of strict inference follow the line of traditional logical deduction. As the characterizations of objects are incomplete and requests are typically partial descriptions of the information need, the rules of strict inference are supplemented with a rule of plausible inference. This rule of plausible inference is motivated by recent work in the area of plausible reasoning in knowledge based systems and, in particular, is derived from the work on belief networks. Some preliminary experimental results are also presented. ESA

N93-27929# Utrecht State Univ. (Netherlands). Dept. of Computer Science.
INDEX EXPRESSION BELIEF NETWORKS FOR INFORMATION DISCLOSURE
P. D. Bruza (Nijmegen Univ., Netherlands.) and L. C. vanderGaag Jun. 1992 32 p Sponsored in part by EEC/ESPRIT
(RUU-CS-92-21; ETN-93-93290) Avail: CASI HC A03/MF A01

The incorporation of semantics into the retrieval mechanism to extend the effectiveness of information disclosure is addressed. A promising mechanism for information disclosure, called the Refinement Machine, is described. The Refinement Machine features the language of index expressions as a language for characterizing information objects and a deduction mechanism driven by rules of inference. Two types of inference rules are distinguished. The rules of strict inference follow the line of traditional logical deduction. As the characterizations of objects are incomplete and requests are typically partial descriptions of the information need, the rules of strict inference are supplemented with a rule of plausible inference. This rule of plausible inference is motivated by recent work in the area of plausible reasoning in knowledge based systems and, in particular, is derived from the work on belief networks. Some preliminary experimental results are also presented. ESA

N93-28005# Westinghouse Savannah River Co., Aiken, SC.
DATA BANKS OF CHEMICAL SUBSTANCES AND THEIR TOXICITY
D. K. Craig 1992 11 p Presented at the Data Banks for Risk Assessment Workshop, Augusta, GA, 2-3 Feb. 1993
(Contract DE-AC09-89SR-18035)
(DE93-006170; WSRC-MS-92-476; CONF-930243-3) Avail: CASI HC A03/MF A01

Rapid proliferation in the development of new chemical compounds, coupled with the discovery and/or identification of those already in existence, has led to a significant need to investigate their physicochemical and biological properties, to document the knowledge gained, and to communicate that knowledge in as convenient a manner as possible. This paper presents and briefly discusses several prominent chemical databases. DOE

N93-28063# Utrecht State Univ. (Netherlands). Dept. of Computer Science.
CURRENT TRENDS IN THE SEMANTICS OF DATAFLOW
Joost N. Kok Jun. 1992 22 p
(RUU-CS-92-22; ETN-93-93291) Avail: CASI HC A03/MF A01

A report to present semantic models for (possibly nondeterministic) dataflow in a uniform way is presented. Besides an operational model, models based on histories, streams, and traces, are given, and the results about full abstraction are collected. A method for describing the behavior of networks with equations is given. As a new element, it is shown how the hiaton model (a relational stream model) can be made fully abstract by adding elements to the relation. ESA

N93-28072# Arizona Univ., Tucson.
INFORMATION EXTRACTION AND INTEGRATION IN MINERAL EXPLORATION Ph.D. Thesis
Adel Ahmed Mahmoud El-Fouly 1992 219 p
Avail: Univ Microfilms Order No. DA9310594

Geologic information extraction and integration are the main goals of this study. Tools are designed to aid in exploration for common mineral deposits by intelligently and efficiently processing spatial geological data. Gabor filters, comprising Gaussian-attenuat ed sinusoidal weight vectors, are used for textural discrimination. A highly nonlinear logic operator was designed for 'valley,' 'ridge,' edge, and intersection extraction from multispectral images to cover most of the possible local lineament types. A zonation detector indicates the presence or absence of lithologic zonation. Two different types of raster-based expert systems help optimize pixel-by-pixel knowledge extraction and representation over the spatial information and throughout the different raster feature layers. First a 2-D expert system is used for classification, ranking, recognition, and searching for important pattern associations in the feature space. Second, a multilayer adaptive raster-based expert system allows the processing of multiple geologic features, and operates over each pattern in the feature layers. The fuzzy integral method of evidence fusion is used to integrate information from a variety of mineral exploration sources. This nonlinearly combines objective mineral occurrence evidence, in the form of a fuzzy membership function, with subjective evaluation of the worth of the sources with respect to the decision. An application of these methods to the Tombstone mineral district in southern Arizona demonstrates its ability to pick out circular

features from TM imagery, Gabor transforms and lineament patterns, as well as identify favorable zonation for new mineral occurrence. The final product at this time is a probability map to guide the exploration geologist. Dissert. Abstr.

N93-28130*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
PICTURE DATA COMPRESSION CODER USING SUBBAND/TRANSFORM CODING WITH A LEMPEL-ZIV-BASED CODER Patent Application
Daniel R. Glover, inventor (to NASA) 11 Mar. 1993 18 p
(NASA-Case-LEW-15700-1; NAS 1.71:LEW-15700-1;
US-Patent-Appl-SN-029520) Avail: CASI HC A03/MF A01

The present invention is a subband/transform coding system. The invention produces a digitally encoded signal which is a transformed version of an analog signal such as a video signal. The digitally encoded signal maintains the integrity of the original signal but allows transmission at low data rates. The transformed data is organized into frequency subbands with the lowest frequency subband being a low resolution version of the original signal. Once the data is transformed into subbands, it is coded with statistical coders. The statistical coder used in this invention is a Lempel-Ziv-based coder. NASA

N93-28390# Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
SEMANTIC MODELS FOR DISTRIBUTED DATA BASE MANAGEMENT. PART 1: DEVELOPMENT OF A METAMODEL FOR FRAGMENTATION [SEMANTISCHE MODELLEN VOOR GEDISTRIBUEERD DATABASE MANAGEMENT. 1. DE ONTWIKKELING VAN EEN METAMODEL VOOR FRAGMENTATIE]
J. A. Bakker 1992 37 p In DUTCH
(Rept-92-33; ETN-93-93125) Copyright Avail: CASI HC A03/MF A01

Distributed Database Management Systems (D-DBMS) were investigated with a view to the development of semantic metamodels for (logic) fragmentation and (physical) allocation of data. The different reasons for the utilization of a distributed database are discussed. The functional requirements for a D-DBMS are outlined. In order to avoid unnecessary complexity it is supposed that all sites of a prototype semantic D-DBMS are connected with a network system, have the same hardware architecture, and use the same operating system, communication protocol and Xplain semantic data language. The difference between horizontal and vertical fragmentation is explained. ESA

N93-26697*# Arizona Univ., Tucson. Dept. of Aerospace and Mechanical Engineering.
AN INTEGRATED DATABASE WITH SYSTEM OPTIMIZATION AND DESIGN FEATURES
A. Arabyan, P. E. Nikravesh, and T. L. Vincent *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 8 p (For primary document see N93-26674 10-91)
Avail: CASI HC A02/MF A03; 1 functional color page

N93-26698*# Arizona Univ., Tucson. Steward Observatory.
THE STEWARD OBSERVATORY ASTEROID RELATIONAL DATABASE
Mark V. Sykes and Elizabeth M. AlvarezdelCastillo *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 5 p (For primary document see N93-26674 10-91)
Avail: CASI HC A01/MF A03; 1 functional color page

N93-26699*# Planetary Science Inst., Tucson, AZ.
NEAR-EARTH ASTEROIDS: OBSERVER ALERT NETWORK AND PHYSICAL OBSERVATIONS
Donald R. Davis and Clark R. Chapman *In* Arizona Univ., NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 7 p (For primary document see N93-26674 10-91)
Avail: CASI HC A02/MF A03; 1 functional color page

N93-26996# Meteorological Satellite Center, Tokyo (Japan). Working Group on Data Archiving.
A USAGE AND MAINTENANCE OF METEOROLOGICAL SATELLITE DATA
In its Meteorological Satellite Center Technical Note, No. 25, 1992 Nov. 1992 p 73-87 In JAPANESE (For primary document see N93-26991 10-47)
Avail: CASI HC A03/MF A02

N93-27705*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
TECHNOLOGY FOR SPACE STATION EVOLUTION: THE DATA MANAGEMENT SYSTEM
L. Abbott *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems 1990 p 5-35 (For primary document see N93-27704 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

N93-27707*# Draper (Charles Stark) Lab., Inc., Cambridge, MA.
VALIDATED FAULT TOLERANT ARCHITECTURES FOR SPACE STATION
Jaynarayan H. Lala *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems 1990 p 75-101 (For primary document see N93-27704 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

N93-27709*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
HIGH RATE SCIENCE DATA HANDLING
Richard C. Masline *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems 1990 p 111-128 (For primary document see N93-27704 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

N93-27710*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
OPTICAL DISK TECHNOLOGY SPACEFLIGHT OPTICAL DISK RECORDER (SODR)
Pamela Rinsland *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems 1990 p 129-139 (For primary document see N93-27704 10-18)
Avail: CASI HC A02/MF A04; 1 functional color page

N93-27714*# National Inst. of Standards and Technology, Gaithersburg, MD.
DATA MANAGEMENT STANDARDS IN COMPUTER-AIDED ACQUISITION AND LOGISTIC SUPPORT (CALS)
David K. Jefferson *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems 1990 p 197-225 (For primary document see N93-27704 10-18)
Avail: CASI HC A03/MF A04; 1 functional color page

N93-27857*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
DATA MANAGEMENT SYSTEM TECHNOLOGY DISCIPLINE
Harry F. Benz *In* NASA, Washington, Technology for Space Station Evolution. Executive Summary and Overview 1990 p 59-83 (For primary document see N93-27854 10-18)
Avail: CASI HC A03/MF A03; 1 functional color page

N93-28286*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
MATERIALS AND PROCESSES TECHNICAL INFORMATION SYSTEM (MAPTIS) LDEF MATERIALS DATA BASE
Joan G. Funk, John W. Strickland (BAMSI, Inc., Huntsville, AL.), and John M. Davis (National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.) *In its* LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 1201-1222 (For primary document see N93-28254 10-99)
Avail: CASI HC A03/MF A04; 2 functional color pages

N93-28287*# Boeing Defense and Space Group, Seattle, WA.
DATA BASES FOR LDEF RESULTS
Gail Bohnhoff-Hlavacek *In* NASA. Langley Research Center, LDEF: 69

Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 1223-1233 (For primary document see N93-28254 10-99)
(Contract NAS1-19247)
Avail: CASI HC A03/MF A04; 2 functional color pages

N93-28288*# Aerospace Corp., El Segundo, CA.
LONG DURATION EXPOSURE FACILITY EXPERIMENT M0003 DEINTEGRATION OBSERVATION DATA BASE
S. R. Gyetvay, J. M. Coggi, and M. J. Meshishnek *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 1235-1246 (For primary document see N93-28254 10-99)
Avail: CASI HC A03/MF A04; 2 functional color pages

83 ECONOMICS AND COST ANALYSIS

Includes cost effectiveness studies.

N93-27013*# Cornell Univ., Ithaca, NY. Dept. of Computer Science.
UNDECIDABILITY IN MACROECONOMICS
Siddharth Chandra and Tushar Deepak Chandra 28 Apr. 1993 40 p Sponsored in part by IBM Endicott Programming Laboratory and Siemens Corp.
(Grants NAG2-593; NSF CCR-91-02231)
(NASA-CR-192979; NAS 1.26:192979; CU-TR-93-1340) Avail: CASI HC A03/MF A01

In this paper we study the difficulty of solving problems in economics. For this purpose, we adopt the notion of undecidability from recursion theory. We show that certain problems in economics are undecidable, i.e., cannot be solved by a Turing Machine, a device that is at least as powerful as any computational device that can be constructed. In particular, we prove that even in finite closed economies subject to a variable initial condition, in which a social planner knows the behavior of every agent in the economy, certain important social planning problems are undecidable. Thus, it may be impossible to make effective policy decisions. Philosophically, this result formally brings into question the Rational Expectations Hypothesis which assumes that each agent is able to determine what it should do if it wishes to maximize its utility. We show that even when an optimal rational forecast exists for each agency (based on the information currently available to it), agents may lack the ability to make these forecasts. For example, Lucas describes economic models as 'mechanical, artificial world(s), populated by ... interacting robots'. Since any mechanical robot can be at most as computationally powerful as a Turing Machine, such economies are vulnerable to the phenomenon of undecidability. Author

N93-28175*# Massachusetts Inst. of Tech., Cambridge.
COST AVERAGING TECHNIQUES FOR ROBUST CONTROL OF FLEXIBLE STRUCTURAL SYSTEMS
Nesbitt W. Hagood and Edward F. Crawley *In its* The 3rd Annual Controlled Structures Technology Symposium 1 Jul. 1991 22 p (For primary document see N93-28167 10-39)
Avail: CASI HC A03/MF A03

84 LAW, POLITICAL SCIENCE AND SPACE POLICY

Includes NASA appropriation hearings; aviation law; space law and policy; international law; international cooperation; and patent policy.

N93-27825# General Accounting Office, Washington, DC. National Security and International Affairs Div.
SPACE STATION: INFORMATION ON NATIONAL SECURITY APPLICATIONS AND COST. REPORT TO THE HONORABLE JOHN W. WARNER, US SENATE
May 1993 15 p
(GAO/NSIAD-93-208; B-253473) Avail: CASI HC A03/MF A01; GAO, PO Box 6015, Gaithersburg, MD 20877 HC

The Department of Defense (DoD) has no formal requirement for a manned space station for national security purposes. In fact, for many of DoD'S space research needs, the facilities of Space Station Freedom would be less suitable than those currently available on the space shuttle. Some research that DoD currently conducts on the shuttle, particularly that which would benefit from extended stays in orbit, could be enhanced by the capabilities of the space station. However, certain shuttle upgrades might satisfy additional DoD research needs. In March 1993, NASA revised its cost estimate for the station to $31.3 billion. At the same time, NASA stretched the schedule for having permanent occupants in the space station to 2000. The $31.3 billion estimate, like previous estimates, excluded substantial budgetary resources required to successfully complete development and support the station over its planned 30-year life. Additional funding necessary to support and outfit the station for permanent occupancy would be another $11.7 billion. Further, at least $78 billion would be required to bring the facility to its full planned capability and maintain, supply, and operate the station after permanent occupancy was achieved. When these costs are included, the space station funding requirements through 2027 would be at least $121 billion. This report responds to a request that we do the following: (1) provide information on the potential use of SSF by the DoD; (2) update information of SSF's total cost; and (3) identify other existing and planned space stations. Author (revised)

85 URBAN TECHNOLOGY AND TRANSPORTATION

Includes applications of space technology to urban problems; technology transfer; technology assessment; and surface and mass transportation.

For related information see also *03 Air Transportation and Safety, 16 Space Transportation,* and *44 Energy Production and Conversion.*

No abstracts in this category.

88 SPACE SCIENCES (GENERAL)

No abstracts in this category.

89 ASTRONOMY

Includes radio, gamma-ray, and infrared astronomy, and astrometry.

N93-27057*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
ANNULAR SOLAR ECLIPSE OF 10 MAY 1994
Fred Espenak and Jay Anderson (Prairie Weather Centre, Winnipeg, Manitoba.) Apr. 1993 90 p
(RTOP 693-00-00)
(NASA-RP-1301; NAS 1.61:1301; Rept-93B00052) Avail: CASI HC A05/MF A01

An annular eclipse of the Sun will be widely visible from the Western Hemisphere on 10 May 1994. The path of the Moon's shadow passes through Mexico, the United States of America, maritime Canada, the North Atlantic, the Azores and Morocco. Detailed predictions for this event are presented and include tables of geographic coordinates of the annular path, local circumstances for hundreds of cities, maps of the path of annular and partial eclipse, weather prospects, and the lunar limb profile. Author

N93-27116*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
CORDOBA DURCHMUSTERUNG, VOLUME 1
Washington May 1993 454 p
(Contract NAS5-30960; RTOP 633-00-00)
(NASA-RP-1299-Vol-1; Rept-93B00049-Vol-1; NAS 1.61:1299-Vol-1) Avail: CASI HC A20/MF A04

The 'Cordoba Durchmusterung' (CD) is a visual survey of southern stars in the declination zones -22 to -89 deg, carried out as an extension to the 'Bonner Durchmusterung' (BD) catalogs of Argelander and Schoenfeld. This volume covers the declination range -22 deg through -30 deg. The survey was performed using techniques similar to those used for the BD; i.e., the stars were cataloged by allowing the telescope to drift along the mean declination of each zone and recording the positions and magnitudes of stars crossing the transit line of the field. The goal of the survey was to obtain a position and estimated visual magnitude for every star down to 10.0 magnitude inclusive, but the faint limit was confirmed from comparisons with other catalogs, to be somewhat below 10. The positions are given to 0.1 s in right ascension and 0.1 min in declination for the equinox 1875. The positional uncertainties quoted in the original publications are plus or minus 0.42 s and plus or minus 0.23 min for zones -22 deg to -32 deg. A list of all corrections made to the original data as a result of published corrigenda is presented. No other corrections or changes were incorporated into the original data, e.g., from more modern positions and magnitudes or comparison with the 'Cape Photographic Durchmusterung'.

Author (revised)

N93-27117*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
CORDOBA DURCHMUSTERUNG, VOLUME 2
Washington May 1993 422 p
(Contract NAS5-30960; RTOP 633-00-00)
(NASA-RP-1299-Vol-2; Rept-93B00049-Vol-2; NAS 1.61:1299-Vol-2) Avail: CASI HC A18/MF A04

The 'Cordoba Durchmusterung' (CD) is a visual survey of southern stars in the declination zones -22 to -89 deg, carried out as an extension to the 'Bonner Durchmusterung' (BD) catalogs of Argelander and Schoenfeld. This volume covers the declination range -31 deg through -39 deg. The survey was performed using techniques similar to those used for the BD; i.e., the stars were cataloged by allowing the telescope to drift along the mean declination of each zone and recording the positions and magnitudes of stars crossing the transit line of the field. The goal of the survey was to obtain a position and estimated visual magnitude for every star down to 10.0 magnitude inclusive, but the faint limit was confirmed from comparisons with other catalogs, to be somewhat below 10. The positions are given to 0.1 s in right ascension and 0.1 min in declination for the equinox 1875. The positional uncertainties quoted in the original publications are plus or minus 0.42 s and plus or minus 0.23 min for zones -22 deg to -32 deg. A list of all corrections made to the original data as a result of published corrigenda is presented. No other corrections or changes were incorporated into the original data, e.g., from more modern positions and magnitudes or comparison with the 'Cape Photographic Durchmusterung'.

Author (revised)

N93-27118*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
CORDOBA DURCHMUSTERUNG, VOLUME 3
Washington May 1993 429 p
(Contract NAS5-30960; RTOP 633-00-00)
(NASA-RP-1299-Vol-3; Rept-93B00049-Vol-3; NAS 1.61:1299-Vol-3) Avail: CASI HC A19/MF A04

The 'Cordoba Durchmusterung' (CD) is a visual survey of southern stars in the declination zones -22 to -89 deg, carried out as an extension to the 'Bonner Durchmusterung' (BD) catalogs of Argelander and Schoenfeld. This volume covers the declination range -40 deg through -49 deg. The survey was performed using techniques similar to those used for the BD; i.e., the stars were cataloged by allowing the telescope to drift along the mean declination of each zone and recording the positions and magnitudes of stars crossing the transit line of the field. The goal of the survey was to obtain a position and estimated visual magnitude for every star down to 10.0 magnitude inclusive, but the faint limit was confirmed from comparisons with other catalogs, to be somewhat below 10. The positions are given to 0.1 s in right ascension and 0.1 min in declination for the equinox 1875. The positional uncertainties quoted in the original publications are plus or minus 0.42 s and plus or minus 0.23 min for zones -22 deg to -32 deg. A list of all corrections made to the original data as a result of published corrigenda is presented. No other corrections or changes were incorporated into the original data, e.g., from more modern positions and magnitudes or comparison with the 'Cape Photographic Durchmusterung'.

Author (revised)

N93-27119*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
CORDOBA DURCHMUSTERUNG, VOLUME 4
Washington May 1993 428 p
(Contract NAS5-30960; RTOP 633-00-00)
(NASA-RP-1299-Vol-4; Rept-93B00049-Vol-4; NAS 1.61:1299-Vol-4) Avail: CASI HC A19/MF A04

The 'Cordoba Durchmusterung' (CD) is a visual survey of southern stars in the declination zones -22 to -89 deg, carried out as an extension to the 'Bonner Durchmusterung' (BD) catalogs of Argelander and Schoenfeld. This volume covers the declination range -40 deg through -49 deg. The survey was performed using techniques similar to those used for the BD; i.e., the stars were cataloged by allowing the telescope to drift along the mean declination of each zone and recording the positions and magnitudes of stars crossing the transit line of the field. The goal of the survey was to obtain a position and estimated visual magnitude for every star down to 10.0 magnitude inclusive, but the faint limit was confirmed from comparisons with other catalogs, to be somewhat below 10. The positions are given to 0.1 s in right ascension and 0.1 min in declination for the equinox 1875. The positional uncertainties quoted in the original publications are plus or minus 0.42 sec and plus or minus 0.23 min for zones -22 deg to -32 deg. A list of all corrections made to the original data as a result of published corrigenda is presented. No other corrections or changes were incorporated into the original data, e.g., from more modern positions and magnitudes or comparison with the 'Cape Photographic Durchmusterung'.

Author (revised)

N93-27382*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
BONNER DURCHMUSTERUNG, VOLUME 1
Washington May 1993 472 p
(Contract NAS5-30960; RTOP 633-00-00)
(NASA-RP-1297-Vol-1; Rept-93B00049-Vol-1; NAS 1.61:1297-Vol-1) Avail: CASI HC A20/MF A04

The Bonner Durchmusterung (BD) is a visual survey of stars in the declination zones +89 deg to -01 deg. This volume contains the data for the declination range +89 deg to +30 deg. The survey, completed by Argelander and his assistants in the years 1852-1861, was performed and the stars cataloged by allowing the telescope to drift along the mean declination of each zone and recording the positions and magnitudes of stars crossing the transit line of each field. The goal of the survey was to obtain a position and estimated visual magnitude for every star visible with the 78-mm Bonn telescope. Actual magnitude estimates were made and reported to 0.1 mag for all stars down to 9.5 mag, with fainter stars being assigned to 9.5. The positions are given to 0.1 s in right ascension and 0.1 min in declination for the equinox 1855. No corrections or changes were incorporated into the original data, except those listed (e.g., no changes were introduced from more modern positions and magnitudes or from comparison with other catalogs). Author (revised)

N93-27383*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
BONNER DURCHMUSTERUNG, VOLUME 2
Washington May 1993 462 p
(Contract NAS5-30960; RTOP 633-00-00)
(NASA-RP-1297-Vol-2; Rept-93B00049-Vol-2; NAS 1.61:1297-Vol-2) Avail: CASI HC A20/MF A04

The Bonner Durchmusterung (DB) is a visual survey of stars in the declination zones +89 deg to -01 deg. This volume contains the data for the declination range +29 deg to -01 deg. The survey, completed by Argelander and his assistants in the years 1852-1861, was performed and the stars cataloged by allowing the telescope to drift along the mean declination of each zone and recording the positions and magnitudes of

stars crossing the transit line of each field. The goal of the survey was to obtain a position and estimated visual magnitude for every star visible with the 78-mm Bonn telescope. Actual magnitude estimates were made and reported to 0.1 s in right ascension and 0.1 min in declination for the equinox 1855. No corrections or changes were incorporated into the original data, except those listed in the introduction (e.g., no changes were introduced from more modern positions and magnitudes or from comparison with other catalogs). Author (revised)

N93-27533*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
WASHINGTON DOUBLE STAR CATALOG CROSS INDEX (1950 POSITION SORT)
Washington May 1993 429 p
(Contract NAS5-30960; RTOP 633-00-00)
(NASA-RP-1302; Rept-93B00053; NAS 1.61:1302) Avail: CASI HC A19/MF A04

A machine-readable version of the Washington Catalog of Visual Double Stars (WDS) was prepared in 1984 on the basis of a data file that was collected and maintained for more than a century by a succession of double-star observers. Although this catalog is being continually updated, a new copy for distribution is not expected to be available for a few years. The WDS contains DM numbers, but many of these are listed only in the notes, which makes it difficult to search for double-star information, except by position. Hence, a cross index that provides complete DM identifications is desirable, and it appears useful to add HD numbers for systems in that catalog. Aitken Double Star (ADS) numbers were retained from the WDS, but no attempt was made to correct these except for obvious errors. Author (revised)

N93-28414*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
SUPPORTING RESEARCH AND TECHNOLOGY ACTIVITIES IN THE PREPARATION OF A THREE-DIMENSIONAL MAP OF THE INFRARED SKY Final Report, 15 Mar. 1986 - 31 Mar. 1993
Jill C. Tarter 31 Mar. 1993 8 p
(Contract NCC2-407)
(NASA-CR-193075; NAS 1.26:193075) Avail: CASI HC A02/MF A01

The final report for the period 15 Mar. 1986 to 31 Mar. 1993 for the Cooperative Agreement is presented. The purpose of this Cooperative Agreement was to collaborate with NASA civil servant and contractor personnel, and other Institute personnel in a project to use all available cataloged astronomical infrared data to construct a detailed three dimensional model of the infrared sky. Areas of research included: IRAS colors of normal stars and the infrared excesses in Be stars; galactic structure; how to use the observed IRAS source counts as a function of position to deduce the physical structure of the galaxy; IRAS properties of metal-poor stars; IRAS database studies; and solar space exploration including projects such as the Space Station Gas-Grain Simulator and the Mars Rover/Sample Return Mission. CASI

N93-26707*# University Coll., Cardiff (Wales). Dept. of Physics.
HOW TO GET UNLIMITED OBSERVING TIME ON A 4 METRE TELESCOPE
S. P. Driver *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 1-2 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

N93-26708*# British Columbia Univ., Vancouver.
COSMOLOGY WITH LIQUID MIRROR TELESCOPES
David W. Hogg, Brad K. Gibson, and Paul Hickson *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 3-4 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

N93-27742*# Observatoire de Paris-Meudon (France).
A 380 GHz SIS RECEIVER USING Nb/AlO(x)/Nb JUNCTIONS FOR A RADIOASTRONOMICAL BALLOON-BORNE EXPERIMENT: PRONAOS
P. Febvre, P. Feautrier (Ecole Normale Superieure, Paris, France.), C. Robert, J. C. Pernot (Ecole Normale Superieure, Paris, France.), A. Germont, M. Hanus (Ecole Normale Superieure, Paris, France.), R. Maoli, M. Gheudin, G. Beaudin, and P. Encrenaz (Ecole Normale Superieure, Paris, France.) *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 189-209 Sponsored in part by CNES and CNRS (For primary document see N93-27726 10-31)
Avail: CASI HC A03/MF A06

N93-27785*# Cologne Univ. (Germany). Physikalisches Inst.
A 492 GHz COOLED SCHOTTKY RECEIVER FOR RADIO-ASTRONOMY
J. Hernichel, R. Schieder, J. Stutzki, B. Vowinkel, G. Winnewisser, and Peter Zimmermann *In* Michigan Univ., The Third International Symposium on Space Terahertz Technology: Symposium Proceedings 1992 p 724-730 Sponsored in part by BMFT (For primary document see N93-27726 10-31)
(Contract DFG-SFB-301)
Avail: CASI HC A02/MF A06

90 ASTROPHYSICS

Includes cosmology; celestial mechanics; space plasmas; and interstellar and interplanetary gases and dust.

For related information see also *75 Plasma Physics*.

N93-26706*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
THE EVOLUTION OF GALAXIES AND THEIR ENVIRONMENT
David Hollenbach, ed., Harley A. Thronson, ed. (Wyoming Univ., Laramie.), and J. Michael Shull, ed. (Colorado Univ., Boulder.) Jan. 1993 404 p Presented at the Third Teton Summer School on Astrophysics on the Evolution of Galaxies and Their Environment, Grand Teton National Park, WY, 5-10 Jul. 1992 Sponsored in part by Colorado Univ.; Wyoming Univ.; and NSF
(RTOP 188-44-53)
(NASA-CP-3190; A-93028; NAS 1.55:3190) Avail: CASI HC A18/MF A04

The Third Teton Summer School on Astrophysics discussed the formation of galaxies, star formation in galaxies, galaxies and quasars at high red shift, and the intergalactic and intercluster medium and cooling flows. Observation and theoretical research on these topics was presented at the meeting and summaries of the contributed papers are included in this volume. For individual titles, see N93-26707 through N93-26894.

N93-26707*# University Coll., Cardiff (Wales). Dept. of Physics.
HOW TO GET UNLIMITED OBSERVING TIME ON A 4 METRE TELESCOPE **c89**
S. P. Driver *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 1-2 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

As the astronomical community moves ever more towards fewer and larger telescopes it is not just desirable but essential to make the maximum possible use of these new facilities. The Hitchhiker parallel CCD camera has been specially designed to increase the scientific output of a large telescope by imaging the off-axis field of view. The large data set collected by this instrument consists of deep CCD multicolor data of the distant Universe and is extremely well suited to the study of faint galaxies and their evolution, as well as other areas. The instrument's design and some of its projects are briefly discussed below and demonstrates the scientific value such instruments could have if incorporated on all new telescopes. Author

N93-26708*# British Columbia Univ., Vancouver.
COSMOLOGY WITH LIQUID MIRROR TELESCOPES **c89**
David W. Hogg, Brad K. Gibson, and Paul Hickson *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 3-4 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Liquid mirrors provide an exciting means to obtain large optical telescopes for substantially lower costs than conventional technologies. The liquid mirror concept has been demonstrated in the lab with the construction of a diffraction limited 1.5 m mirror. The mirror surface, using liquid mercury, forms a perfect parabolic shape when the mirror cell is

rotated at a uniform velocity. A liquid mirror must be able to support a heavy mercury load with minimal flexure and have a fundamental resonant frequency that is as high as possible, to suppress the amplitude of surface waves caused by small vibrations transmitted to the mirror. To minimize the transmission of vibrations to the liquid surface, the entire mirror rests on an air bearing. This necessitates the mirror cell being lightweight, due to the limited load capabilities of the air bearing. The mirror components must also have physical characteristics which minimize the effects of thermal expansion with ambient temperature fluctuations in the observatory. In addition, the 2.7 m mirror construction is designed so that the techniques used may be readily extended to the construction of large mirrors. To attain the goals of a lightweight, rigid mirror, a composite laminant construction was used. The mirror consists of a foam core cut to the desired parabolic shape, with an accuracy of a few mm. An aluminum hub serves as an anchor for the foam and skin, and allows precise centering of the mirror on the air bearing and drive system. Several plys of Kevlar, covered in an epoxy matrix, are then applied to the foam. A final layer of pure epoxy is formed by spin casting. This final layer is parabolic to within a fraction of a mm. An aluminum ring bonded to the circumference of the mirror retains the mercury, and incorporates stainless-steel hard-points for the attachment of balance weights. Derived from text

N93-26709*# California Univ., Berkeley. Dept. of Astronomy.
HEAVY ELEMENT ABUNDANCES AND MASSIVE STAR FORMATION
Boqi Wang and Joseph Silk *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 5-6 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

The determination of the stellar initial mass function (IMF) remains a great challenge in astronomy. In the solar neighborhood, the IMF is reasonable well determined for stellar masses from about 0.1 to 60 solar mass. However, outside the solar neighborhood, the IMF is poorly known. Among those frequently discussed arguments favoring a different IMF outside the solar neighborhood are the estimated time to consume the remaining gas in spiral galaxies, and the high rate of forming massive stars in starburst galaxies. An interesting question then is whether there may be an independent way of testing possible variations in the IMF. Indeed, the heavy elements in the interstellar medium are mostly synthesized in massive stars, so increasing, or decreasing, the fraction of massive stars naturally leads to a variation in the heavy element yield, and thus, the metallicity. The observed abundance should severely constrain any deviations of the IMF from the locally determined IMF. We focus on element oxygen, which is the most abundant heavy element in the interstellar medium. Oxygen is ejected only by massive stars that can become Type 1 supernovae, and the oxygen abundance is, therefore, a sensitive function of the fraction of massive stars in the IMF. Adopting oxygen enables us to avoid uncertainties in Type 1 supernovae. We use the nucleosynthesis results to calculate the oxygen yield for given IMF. We then calculate the oxygen abundance in the interstellar medium assuming instantaneous recycling of oxygen.
Derived from text

N93-26710*# Carnegie Institution of Washington, Pasadena, CA.
SURVEY INCOMPLETENESS AND THE EVOLUTION OF THE QSO LUMINOSITY FUNCTION
Steven R. Majewski, Jeffrey A. Munn (Yerkes Observatory, Williams Bay, WI.), Richard G. Kron (Yerkes Observatory, Williams Bay, WI.), Matthew A. Bershady (Yerkes Observatory, Williams Bay, WI.), John J. Smetanka (Yerkes Observatory, Williams Bay, WI.), and David C. Koo (Lick Observatory, Santa Cruz, CA.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 7-8 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

We concentrate on a type of QSO survey which depends on selecting QSO candidates based on combinations of colors. Since QSO's have emission lines and power-law continua, they are expected to yield broadband colors unlike those of stellar photospheres. Previously, the fraction of QSO's expected to be hiding (unselected) within the locus of stellar (U-J, J-F) colors was estimated at about 15 percent. We have now verified that the KK88 survey is at least 11 percent incomplete, but have determined that it may be as much as 34 percent incomplete. The 'missing' QSO's are expected to be predominantly at z less than or = 2.2. We have studied the proper motion and variability properties of all stellar objects with J less than or = 22.5 or F less than or = 21.5 in the SA 57 field which has previously been surveyed with a multicolor QSO search by KK88.
Derived from text

N93-26711*# Colorado Univ., Boulder. Joint Inst. for Lab. Astrophysics.
OMEGA FROM THE ANISOTROPY OF THE REDSHIFT CORRELATION FUNCTION
A. J. S. Hamilton *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 9-14 (For primary document see N93-26706 10-90)
Avail: CASI HC A02/MF A04

Peculiar velocities distort the correlation function of galaxies observed in redshift space. In the large scale, linear regime, the distortion takes a characteristic quadrupole plus hexadecapole form, with the amplitude of the distortion depending on the cosmological density parameter omega. Preliminary measurements are reported here of the harmonics of the correlation function in the CfA, SSRS, and IRAS 2 Jansky redshift surveys. The observed behavior of the harmonics agrees qualitatively with the predictions of linear theory on large scales in every survey. However, real anisotropy in the galaxy distribution induces large fluctuations in samples which do not yet probe a sufficiently fair volume of the Universe. In the CfA 14.5 sample in particular, the Great Wall induces a large negative quadrupole, which taken at face value implies an unrealistically large omega 20. The IRAS 2 Jy survey, which covers a substantially larger volume than the optical surveys and is less affected by fingers-of-god, yields a more reliable and believable value, omega = 0.5 sup +.5 sub -.25. Author

N93-26712*# Colorado Univ., Boulder. Joint Inst. for Lab. Astrophysics.
WAYS TO IMPROVE YOUR CORRELATION FUNCTIONS
A. J. S. Hamilton *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 15-20 (For primary document see N93-26706 10-90)
Avail: CASI HC A02/MF A04

This paper describes a number of ways to improve on the standard method for measuring the two-point correlation function of large scale structure in the Universe. Issues addressed are: (1) the problem of the mean density, and how to solve it; (2) how to estimate the uncertainty in a measured correlation function; (3) minimum variance pair weighting; (4) unbiased estimation of the selection function when magnitudes are discrete; and (5) analytic computation of angular integrals in background pair counts. Author

N93-26713*# Canadian Inst. for Theoretical Astrophysics, Toronto (Ontario).
PRIMEVAL GALAXIES IN THE SUB-mm AND mm
J. Richard Bond and Steven T. Myers *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 21-22 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Although the results of COBE's FIRAS experiment 1 constrain the deviation in energy from the CMB blackbody in the 500-5000 micron range to be delta E/E, sub cmb less than 0.005, primeval galaxies can still lead to a brilliant sub-mm sky of non-Gaussian sources that are detectable at 10 inch resolution from planned arrays such as SCUBA on the James Clerk Maxwell Telescope and, quite plausibly, at sub-arcsecond resolution in planned mm and sub-mm interferometers. Here, we apply our hierarchical peaks method to a CDM model to construct sub-mm and mm maps of bursting PG's appropriate for these instruments with minimum contours chosen to correspond to realistic observational parameters for them and which pass the FIRAS limits. Author

N93-26714*# California Inst. of Tech., Pasadena.
TWO SEARCHES FOR PRIMEVAL GALAXIES
D. Thompson, S. Djorgovski, and J. Trauger (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 23-24 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

A number of active galaxies are now known at very large redshifts, some of them even have properties suggestive of galaxies in the process of formation. They commonly show strong Ly-alpha emission, at least some of which appears to be ionized by young stars. Inferred star formation

rates are in the range approximately = 100-500 solar mass/yr. An important question is: are there radio-quiet, field counterparts of these systems at comparable redshifts? Whereas, we are probably already observing some evolutionary and formative processes of distant radio galaxies, the ultimate goal is to observe normal galaxies at the epoch when most of their stars form. We have, thus, started a search for emission-line objects at large redshifts, ostensibly young and forming galaxies. Our method is to search for strong line emission (hopefully Ly alpha) employing two techniques: a direct, narrow-band imaging search, using a Fabry-Perot interferometer; and a serendipitous long-slit spectroscopic search. Author

N93-26715*# Wyoming Univ., Laramie. Infrared Observatory.
SOME EFFECTS OF DUST ON PHOTOMETRY OF HIGH-z GALAXIES: CONFOUNDING THE EFFECTS OF EVOLUTION
H. A. Thronson, Jr., A. N. Witt (Ritter Observatory, Toledo, OH.), and J. Capuano (Ritter Observatory, Toledo, OH.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 25-26 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Photometric observations of very distant galaxies--e.g., color vs. z or magnitude vs. z, have been used over the past decade or so in investigations into the evolution of the stellar component. Numerous studies have predicted significant color variations as a result of evolution, in addition to the shifting of different rest wavelengths into the band of observation. Although there is significant scatter, the data can be fit with relatively straightforward, plausible models for galaxian evolution. In very few cases are the effects of dust extinction included in the models. This is due in a large part to the uncertainty about the distribution and optical properties of the grains, and even whether or not they are present in significant numbers in some types of galaxies such as ellipticals. It is likely that the effects of dust on broadband observations are the greatest uncertainty in studies of very distant galaxies. We use a detailed Monte Carlo radiative transfer model within a spherical geometry for different star/dust distributions to examine the effects of dust on the broadband colors of galaxies as a function of redshift. The model fully accounts for absorption and angular redistribution in scattering. In this summary, we consider only the effects on color vs. redshift for three simple geometries each with the same total dust optical depth. Elsewhere at this conference, Capuano, Thronson, & Witt consider other effects of altering the relative dust/star distribution. Author

N93-26716*# Chicago Univ., IL. Center for Astrophysical Research in Antarctica.
THE NATURE OF FAINT EMISSION-LINE GALAXIES
John J. Smetanka *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 27-28 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

One of the results of faint galaxy redshift surveys is the increased fraction of galaxies which have strong emission-line spectra. These faint surveys find that roughly 50 percent of the galaxies have an equivalent width of (OII), W sub 3727, greater than 20 A while this fraction is less than 20 percent in the DARS survey. This has been interpreted as evidence for strong evolution in the galaxy population at redshifts less than 0.5. In order to further investigate the properties of the galaxies in faint redshift surveys, two important factors must be addressed. The first is the observed correlation between color, luminosity, and W sub 3727. There is a correlation between color and the strength of emission lines, bluer galaxies having stronger emission features, as evident for Markarian galaxies and for galaxies in Kennicutt's spectrophotometric atlas. This correlation also applies galaxies in faint redshift surveys. In addition, low luminosity galaxies have a larger average W sub 3727 (and bluer colors) than higher luminosity galaxies. This is illustrated for Kennicutt's low z late-type galaxies, for the Durham Faint Surveys, and for galaxies in SA68. The second factor which must be incorporated into any interpretation of the faint emission galaxies is the different luminosity functions for galaxies depending on color. This is usually modeled by varying M* for different color classes (or morphological types); however, the shape of the luminosity function is different for galaxies with different colors. Low luminosity, blue galaxies have a much larger number density than low luminosity, red galaxies. Furthermore, the low luminosity end of the blue galaxy luminosity function is not well fit by a Schechter function. These two factors have been included in a very simple, no-evolution, model for the galaxy population. This model uses the luminosity functions from Shanks (1990) and spectral energy distributions (SED's) from Bruzual (1988). W sub 3727 is predicted using the correlation (including dispersion) with color. Author

N93-26717*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
TWO PROTOGALAXY CANDIDATES IN ONE NIGHT
Peter Eisenhardt and Mark Dickinson (California Univ., Berkeley.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 29-30 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

In spite of a lookback time of 77 to 89 percent of the age of the universe, Lilly provided evidence that the dominant stellar population in 0902 was surprisingly old, over 1 Gyr. This age estimate was based on the values K = 18.8 and I-K = 4.5 in the central 3.5 x 3.5 inch. At Lilly's suggestion, we reobserved 0902 at K, and in initial reductions of our data found only an upper limit (K greater than 19.5). After extensive experimentation with reduction techniques and correction for low-level systematic effects, we succeeded in extracting a four sigma detection at K = 19.9 in a 4 inch diameter circular aperture. The morphology and location of this detection were more reminescent of the Ly alpha image than of CCD continuum images, and in Mar. 1992, we obtained a narrow band image which included redshifted (OIII) 4959,5007 A line emission at 2.20 microns. This (OIII) image gave a strong detection which demonstrates that most of the central K flux, already reduced by a magnitude, is due to line emission. Our formal line corrected values in a 4 inch aperture are K = 21.5 and R-K = 1.9. Hence, 0902 has been transformed from relaxed maturity into unsettled youth. Derived from text

N93-26718*# Ohio State Univ., Columbus. Dept. of Astronomy.
A COMPARISON OF THE NEAR-INFRARED SPECTRAL FEATURES OF EARLY-TYPE GALAXIES IN THE COMA CLUSTER, THE VIRGO CLUSTER AND THE FIELD
Mark L. Houdashelt and Jay A. Frogel *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 31-32 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Earlier researchers derived the relative distance between the Coma and Virgo clusters from color-magnitude relations of the early-type galaxies in each cluster. They found that the derived distance was color-dependent and concluded that the galaxies of similar luminosity in the two clusters differ in their red stellar populations. More recently, the color-dependence of the Coma-Virgo distance modulus has been called into question. However, because these two clusters differ so dramatically in their morphologies and kinematics, it is plausible that the star formation histories of the member galaxies also differed. If the conclusions of earlier researchers are indeed correct, then some signature of the resulting stellar population differences should appear in the near-infrared and/or infrared light of the respective galaxies. We have collected near-infrared spectra of 17 Virgo and 10 Coma early-type galaxies; this sample spans about four magnitudes in luminosity in each cluster. Seven field E/S0 galaxies have been observed for comparison. Pseudo-equivalent widths have been measured for all of the field galaxies, all but one of the Virgo members, and five of the Coma galaxies. The features examined are sensitive to the temperature, metallicity, and surface gravity of the reddest stars. A preliminary analysis of these spectral features has been performed, and, with a few notable exceptions, the measured pseudo-equivalent widths agree well with previously published values. Derived from text

N93-26719*# Space Telescope Science Inst., Baltimore, MD.
EVERYTHING YOU EVER WANTED TO KNOW ABOUT THE ULTRAVIOLET SPECTRA OF STAR-FORMING GALAXIES BUT WERE AFRAID TO ASK
A. L. Kinney, R. Bohlin, D. Calzetti, N. Panagia, and R. Wyse (Johns Hopkins Univ., Baltimore, MD.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 33 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

We present ultraviolet spectra of 143 star-forming galaxies of different morphological types and activity classes including S0, Sa, Sb, Sc, Sd, irregular, starburst, blue compact, blue compact dwarf, Liner, and Seyfert 2 galaxies. These IUE spectra cover the wavelength range from 1200 to

3200 A and are taken in a large aperture (10 x 20 inch). The ultraviolet spectral energy distributions are shown for a subset of the galaxies, ordered by spectral index, and separated by type for normal galaxies, Liners, starburst galaxies, blue compact (BCG) and blue compact dwarf (BCDG) galaxies, and Seyfert 2 galaxies. The ultraviolet spectra of Liners are, for the most part, indistinguishable from the spectra of normal galaxies. Starburst galaxies have a large range of ultraviolet slope, from blue to red. The star-forming galaxies which are the bluest in the optical (BCG and BCDG), also have the 'bluest' average ultraviolet slope of beta = -1.75 +/- 0.63. Seyfert 2 galaxies are the only galaxies in the sample that consistently have detectable UV emission lines. Author

N93-26720*# Space Telescope Science Inst., Baltimore, MD.
THE ULTRAVIOLET SIGNATURE OF MASSIVE STARS IN STARBURST GALAXIES Progress Report
Robert Carmelle, Claus Leitherer (European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk, Netherlands.), and Timothy M. Heckman (Johns Hopkins Univ., Baltimore, MD.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 34-35 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Studies in different spectral regimes of starburst galaxies clearly indicate the presence of hot, massive stars. However, only the UV spectral region can be used to directly identify the spectroscopic signature of these stars. The typical contributor to the integrated continuum at approximately 1400 A of a starburst is from the hot B stars. More massive stars are responsible for the majority to the UV lines which are broad photospheric absorption lines and wind emission or P Cygni profiles. We present a progress report of a study of the massive star population in starburst galaxies using the UV spectral region. Derived from text

N93-26721*# California Inst. of Tech., Pasadena. Palomar Observatory.
A SEARCH FOR QUASAR PROTOCLUSTERS AT z GREATER THAN 4
J. D. Smith, D. Thompson, and S. Djorgovski *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 36-37 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

In the CDM and many other hierarchical scenarios for the origins of large scale structure, the existence of luminous quasars at very high redshifts (z greater than 3 or 4) is difficult to understand, unless such objects form at the very highest peaks of the density field. One then might expect a strong clustering of quasars at large redshifts. This is a generic prediction for practically any reasonable primordial density fluctuation spectrum. For CDM, Efstathiou & Rees (1988) predicted that quasars at z greater than 4 should be clustered as strongly as the bright galaxies at z approx. than 0. Cole & Kaiser (1989) suggest that z greater than 4 quasars might represent greater than or approximately = 4(sigma) peaks of the density field and thus, should be clustered more strongly than galaxies at z approximately = 0. We are performing the following experiment: a search for quasars, AGN, or other discrete objects, e.g., starforming galaxies, near known, z greater than 4 quasars. In other words, use the early quasars as markers of possible protoclusters. This is a fairly basic test of our understanding of the formation of galaxies, large-scale structure, and the origin of the first quasars themselves. Author

N93-26722*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
WIDE-FIELD DIRECT CCD OBSERVATIONS SUPPORTING THE ASTRO-1 SPACE SHUTTLE MISSION'S ULTRAVIOLET IMAGING TELESCOPE
Paul Hintzen (Nevada Univ., Las Vegas.), Ron Angione (San Diego State Univ., CA.), Freddie Talbert (San Diego State Univ., CA.), K.-P. Cheng, Eric Smith, and Theodore P. Stecher *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 38-39 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Wide field direct CCD observations are being obtained to support and complement the vacuum-ultraviolet (VUV) images provided by Astro's Ultraviolet Imaging Telescope (UIT) during a Space Shuttle flight in December 1990. Because of the wide variety of projects addressed by UIT, the fields observed include (1) galactic supernova remnants such as the Cygnus Loop and globular clusters such as Omega Cen and M79; (2) the Magellanic Clouds, M33, M81, and other galaxies in the Local Group; and (3) rich clusters of galaxies, principally the Perseus cluster and Abell 1367. Ground-based observations have been obtained for virtually all of the Astro-1 UIT fields. The optical images allow identification of individual UV sources in each field and provide the long baseline in wavelength necessary for accurate analysis of UV-bright sources. To facilitate use of our optical images for analysis of UIT data and other projects, we plan to archive them, with the UIT images, at the National Space Science Data Center (NSSDC), where they will be universally accessible via anonymous FTP. The UIT, one of three telescopes comprising the Astro spacecraft, is a 38-cm f/9 Ritchey-Chretien telescope on which high quantum efficiency, solar-blind image tubes are used to record VUV images on photographic film. Five filters with passbands centered between 1250A and 2500A provide both VUV colors and a measurement of extinction via the 2200A dust feature. The resulting calibrated VUV pictures are 40 arcminutes in diameter at 2.5 arcseconds resolution. The capabilities of UIT, therefore, complement HST's WFPC: the latter has 40 times greater collecting area, while UIT's usable field has 170 times WFPC's field area. Derived from text

N93-26723*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
RESULTS ON THE EVOLUTION OF GALAXIES AND THEIR ENVIRONMENT FROM THE ULTRAVIOLET IMAGING TELESCOPE ON ASTRO-1
Theodore P. Stecher *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 40 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

The Ultraviolet Imaging Telescope (UIT), part of the Astro-1 Spacelab Mission, was used to obtain high-resolution surface brightness distribution data in six ultraviolet wavelength bands for the bright reflection nebula NGC 7023. The corresponding data from the visible leads us to conclude that the scattering in the near and far ultraviolet in this nebula is more strongly forward directed than it is in the visible. The UIT also obtained near-UV and far-UV images of the giant OB association NGC 206 in M32. Photometry was obtained for thirty massive stars. We analyzed UV imagery of two Sb bulges and two E galaxies obtained with UIT. For NGC 1275, the measured UV colors indicate a mass function which extends to eight solar masses but no higher. Other aspects of this investigation are discussed. Derived from text

N93-26724*# New Mexico State Univ., Las Cruces. Dept. of Astronomy.
THE PECULIAR VELOCITIES OF RICH CLUSTERS IN THE HOT AND COLD DARK MATTER SCENARIOS
George F. Rhee, Michael J. West (Leiden Univ., Netherlands.), and Jens V. Villumsen (Ohio State Univ., Columbus.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 41 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

We present the results of a study of the peculiar velocities of rich clusters of galaxies. The peculiar motion of rich clusters in various cosmological scenarios is of interest for a number of reasons. Observationally, one can measure the peculiar motion of clusters to greater distances than galaxies because cluster peculiar motions can be determined to greater accuracy. One can also test the slope of distance indicator relations using clusters to see if galaxy properties vary with environment. We have used N-body simulations to measure the amplitude and rms cluster peculiar velocity as a function of bias parameter in the hot and cold dark matter scenarios. In addition to measuring the mean and rms peculiar velocity of clusters in the two models, we determined whether the peculiar velocity vector of a given cluster is well aligned with the gravity vector due to all the particles in the simulation and the gravity vector due to the particles present only in the clusters. We have investigated the peculiar velocities of rich clusters of galaxies in the cold dark matter and hot dark matter galaxy formation scenarios. We have derived peculiar velocities and associated errors for the scenarios using four values of the bias parameter ranging from b = 1 to b = 2.5. The growth of the mean peculiar velocity with scale factor has been determined and compared to that predicted by linear theory. In addition, we have compared the orientation of force and velocity in these simulations to see if a program such as that

proposed by Bertschinger and Dekel (1989) for elliptical galaxy peculiar motions can be applied to clusters. The method they describe enables one to recover the density field from large scale redshift distance samples. The method makes it possible to do this when only radial velocities are known by assuming that the velocity field is curl free. Our analysis suggests that this program if applied to clusters is only realizable for models with a low value of the bias parameter, i.e., models in which the peculiar velocities of clusters are large enough that the errors do not render the analysis impracticable. Derived from text

N93-26725*# Lick Observatory, Santa Cruz, CA.
A REVISED CATALOG OF CfA GALAXY GROUPS IN THE VIRGO/GREAT ATTRACTOR FLOW FIELD
Richard Nolthenius *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 42-43 Submitted for publication (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

A new identification of groups and clusters in the CfAI Catalog of Huchra, et al. (1983) is presented, using a percolation algorithm to identify density enhancements. The procedure differs from that of the original Geller and Huchra (1983; GH) catalog in several important respects; galaxy distances are calculated from the Virgo-Great Attractor flow model of Faber and Burnstein (1988), the adopted distance linkage criteria is only approx. 1/4 as large as in the Geller and Huchra catalog, the sky link relation is taken from Nolthenius and White (1987), correction for interstellar extinction is included, and 'by-hand' adjustments to group memberships are made in the complex regions of Virgo/Coma I/Ursa Major and Coma/A1367 (to allow for varying group velocity dispersions and to trim unphysical 'spider arms'). Since flow model distances are poorly determined in these same regions, available distances from the IR Tully-Fisher planetary nebula luminosity function and surface brightness resolution methods are adopted if possible. Derived from text

N93-26726*# Space Telescope Science Inst., Baltimore, MD.
WHAT DETERMINES THE MORPHOLOGICAL FRACTIONS IN CLUSTERS OF GALAXIES?
Bradley C. Whitmore *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 44-45 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

A reexamination of Dressler's (1980) sample of nearly 6000 galaxies in 55 clusters shows that the morphology-clustercentric radius relation is more fundamental than the morphology-local density relation. This conclusion is supported by improved correlations when the projected clustercentric radius is used as the independent parameter, and by a comparison of galaxies with the same normalized clustercentric radii by different values of the projected local density. Derived from text

N93-26727*# Durham Univ. (England).
ENVIRONMENTAL INFLUENCES ON GALAXY EVOLUTION
Stephen E. Zepf and Bradley C. Whitmore (Space Telescope Science Inst., Baltimore, MD.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 46-47 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

We investigate the role of mergers and interactions in the evolution of galaxies by studying galaxies in compact groups. Compact groups of galaxies have high spatial densities and low velocity dispersions making these regions ideal laboratories in which to study the effect of interactions and mergers. Based on a detailed spectroscopic and multi-color imaging study, we find that both the isophotal shapes and the stellar kinematics indicate that many of the elliptical galaxies in compact groups have been affected by tidal interactions. At the same time, however, we find that only a few elliptical galaxies in compact groups have evidence for the young stellar populations that would be expected if they are the result of recent merger of two spiral galaxies. Therefore, we conclude that tidal interactions affect galaxy properties at the current epoch, but the bulk of basic galaxy formation and transformation must have occurred at much higher redshift. Author

N93-26728*# Durham Univ. (England).
GLOBULAR CLUSTER SYSTEMS AS CLUES TO GALAXY EVOLUTION
Stephen E. Zepf and Keith M. Ashman (Canadian Inst. for Theoretical Astrophysics, Toronto, Ontario.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 48-49 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

We investigate the properties of systems of globular clusters in light of the hypothesis that galaxy mergers play a major role in galaxy evolution. In a previous paper, we presented a model in which the formation of globular clusters occurs during galaxy interactions and mergers. We discussed several predictions of the model, including the existence of young globular clusters in currently merging galaxies and the presence of two or more metallicity peaks in the globular clusters systems of normal elliptical galaxies. Here, we present recent observational evidence which supports both of these predictions and suggests that mergers may have a significant influence on the formation and evolution of galaxies and their globular clusters. Author

N93-26729*# Max-Planck-Inst. fuer Extraterrestrische Physik, Garching (Germany).
GLOBULAR CLUSTER FORMATION IN MERGING GALAXIES?
D. Lutz *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 50-51 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

The properties of a population of luminous blue clusters in the merging galaxy NGC 3597 are discussed, and the observability of the signature of such a population in later evolutionary stages of a merger is assessed. NGC 3597 is an advanced merger which has already developed into an elliptical-like object with a de Vaucouleurs brightness distribution, but intense star formation is continuing in the central 4 kpc. A population of unresolved blue objects that are concentrated towards the central region is identified as clusters belonging to NGC 3597. Author

N93-26730*# Canadian Inst. for Theoretical Astrophysics, Toronto (Ontario).
CLUSTER EVOLUTION AS A PROBE OF PRIMORDIAL DENSITY FLUCTUATIONS
J. Richard Bond and Steven T. Myers *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 52-53 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Although COBE's detection of large angle microwave background anisotropies fixes the amplitude of density fluctuations on length scales k exp -1 approximately = (300-6000) h(exp -1)Mpc, what is crucial for the level of large scale clustering is the amplitude of density fluctuations on scales (5-50) h(exp -1)Mpc. The level of dynamical clustering is usually parameterized by the size of the mass fluctuations in 8 h exp -1 Mpc spheres, sigma sub 8. For the cold dark matter model, COBE gives sigma sub 8 approximately = 1, while models with extra large scale power give sigma sub 8 approximately = 1/2. The most massive clusters of galaxies (greater than or approximately = 10 exp 15 solar mass) form from rare 'peak patches' found in the initial mass density distribution. Their abundance as a function of redshift is a sensitive probe of the wave number band k(exp -1) approx. (3-8) h(exp -1)Mpc, hence of sigma sub 8, and so cluster evolution can discriminate among models allowed by the COBE results. We use our Hierarchical Peaks Method, which accurately reproduces the results of P3M N-body simulations, to calculate the evolution of cluster x-ray flux counts, luminosity, and temperature functions as a function of sigma sub 8 for CDM models and those with more large scale power. We find that the EMSS and Edge et al. cluster samples support sigma sub 8 in the range from approx. 0.6-0.9, and that models with more large scale power (and hence flatter fluctuation spectra in the cluster regime) fit the x-ray bright end better. Author

N93-26731*# State Univ. of New York, Stony Brook. Astronomy Program.
CLUSTERING OF VERY LUMINOUS INFRARED GALAXIES AND THEIR ENVIRONMENT
Yu Gao *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 54-55 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

The IRAS survey reveals a class of ultraluminous infrared (IR) galaxies

(ULIRG's) with IR luminosities comparable to the bolometric luminosities of quasars. The nature, origin, and evolution of ULIRG's are attracting more and more attention recently. Since galaxy morphology is certainly a function of environment, morphological observations show that ULIRG's are interacting/merging galaxies, and some ULIRG's might be the dust-enshrouded quasars (S88) or giant ellipticals, the study of ULIRG's environment and large scale clustering effects should be worthwhile. ULIRG's and very luminous IR galaxies have been selected from the 2Jy IRAS redshift survey. Meanwhile, a catalog of IRAS groups of galaxies has been constructed using a percolation-like algorithm. Therefore, whether ULIRG's and/or VLIRG's have a group environment can be checked immediately. Other aspects of the survey are discussed. Derived from text

N93-26732*# California Univ., Berkeley. Dept. of Astronomy.
GALAXY TRACERS IN N-BODY SIMULATIONS
F. J. Summers, August E. Evrard (Michigan Univ., Ann Arbor.), and Marc Davis *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 56-57 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Using the method of smoothed particle hydrodynamics, we have modeled the formation of a compact group of galaxies with sufficient resolution to trace galaxies. Radiative cooling allows the baryons to dissipate their thermal energy and collapse to overdensities characteristic of real galaxies. With their cross section greatly reduced, these galaxy tracers remain distinct during cluster formation while their dark matter halos merge. In addition, the number density, the mass distribution function, and even the morphology of these objects are similar to those of observed galaxies. A viable population of galaxy tracers can be unambiguously defined. Derived from text

N93-26733*# Canadian Inst. for Theoretical Astrophysics, Toronto (Ontario).
THE LARGE-SCALE MORPHOLOGY OF IRAS GALAXIES
Arif Babul, Glenn D. Starkman, and Michael A. Strauss (Institute for Advanced Study, Princeton, NJ.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 58-59 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

At present, visual inspection is the only method for comparing the large-scale morphologies in the distribution of galaxies to those in model universes generated by N-body simulations. To remedy the situation, we have developed a set of three structure functions (S1, S2, S3) that quantify the degree of large-scale prolateness, oblateness, and sphericity/uniformity of a 3-D particle distribution and have applied them to a volume-limited (less than = 4000 km/s) sample of 699 IRAS galaxies with f sub 60 greater than 1.2 Jy. To determine the structure functions, we randomly select 500 galaxies as origins of spherical windows of radius R sub w, locate the centroid of the galaxies in the window (assuming all galaxies have equal mass) and then, compute the principal moments of inertia (I sub 1, I sub 2, I sub 3) about the centroid. Each S sub i is a function of (I sub 2)/(I sub 1) and (I sub 3)/I sub 1). S1, S2, and S3 tend to unity for highly prolate, oblate, and uniform distributions, respectively and tend to zero otherwise. The resulting 500 values of S sub i at each scale R sub w are used to construct a histogram. Author

N93-26734*# Tokyo Univ. of Mercantile Marine (Japan). Dept. of Physics.
SUBCLUSTERING IN THE HIERARCHICAL MODEL OF GALAXY FORMATION
Satoshi Yoshioka *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 60-61 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

We investigate the process of subclustering in the hierarchical model of galaxy formation. We construct density field around peaks of density fluctuations using the path integral method and investigate their nature. Author

N93-26735*# Ohio State Univ., Columbus. Dept. of Astronomy.
THE SPATIAL CORRELATION PROPERTIES OF DARK GALAXY HALOS IN A CDM UNIVERSE
Tereasa G. Brainerd and Jens V. Villumsen *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 62-63 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

We use the Hierarchical Particle Mesh (HPM) N-body code written by J. V. Villumsen (Villumsen, 1989) to investigate the two-point spatial correlation function, xi(r), of dark galaxy halos as a function of halo mass and local environment (i.e. high, low, or average mass density). We assume a standard cold dark matter (CDM) universe (omega = 1, delta = 0, H sub 0 = 50,km/sec/Mpc). Because of the large dynamic ranges in mass and length that can be obtained with the HPM code, it is well-suited to an investigation of this sort. Author

N93-26736*# Michigan Univ., Ann Arbor. Dept. of Physics.
GAS DYNAMIC SIMULATIONS OF GALAXY FORMATION
August E. Evrard *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 64-65 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Results are presented from a simulation modeling the formation of a group of galaxies in a 'standard' cold, dark matter universe with delta = 1, h sub 0 = 50 km/(s(Mpc)), baryon fraction omega sub b = 0.1 and spectrum normalization sigma sub 8 = 0.6 (bias parameter b = 1.7). Initial conditions are generated within a periodic box with comoving length 16 Mpc in a manner constrained to produce a small cluster of total mass approximately 10 exp 14 solar mass. Two sets of 643 particles are used to model the dark matter and baryon fluids. Each gas particle represents 1.08 x 10 exp -8 solar mass, implying an L* galaxy is resolved by approximately 1000 particles. The system is evolved self-consistently in three dimensions using the combined N-body/hydrodynamic scheme P3MSPH up to a final redshift z = 1. Evolving to the present is prohibited by the fact that the mean density in the simulated volume is above critical and the entire volume would be going nonlinear beyond this point, We are currently analyzing another run with somewhat poorer mass resolution which was evolved to the present. Author

N93-26737*# Padua Univ. (Italy). Dipt. di Astronomia.
THE GALAXY VELOCITY FIELD AND CDM MODELS
Giuseppe Tormen (Massachusetts Inst. of Tech., Cambridge.), Lauro Moscardini, Francesco Lucchin, and Sabino Matarrese *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 66-67 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

It is generally accepted that some kind of non-baryonic dark matter accounts for most of the mass density of the universe. Considering such a component has become, in the last decade, a key ingredient in current theories of structure formation. In particular, the Cold Dark Matter (CDM) scenario has proven to be quite successful in explaining most of the observed properties of galaxies and of their large-scale distribution. The standard CDM model is characterized by a primordial Zel'dovich spectrum, of random-phase adiabatic perturbations in a universe with density parameter omega sub 0 = 1 and vanishing cosmological constant. This poster paper presents an analysis of observational data on peculiar motion of optical galaxies in comparison to the predictions of CDM models where the assumptions of the standard scenario: omega sub 0 = 1, n = 1, and bias parameter b = 1 are relaxed. In particular, CDM models with 0 less than n less than 1 and 0.4 less than omega sub 0 less than 1 are considered. Author

N93-26738*# Illinois Univ., Urbana. National Center for Supercomputing Applications.
THE HYDRODYNAMICS OF GALAXY FORMATION ON KILOPARSEC SCALES
Michael L. Norman, Wenbo Yuan Anninos, and Joan Centrella (Drexel Univ., Philadelphia, PA.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 68-69 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Two dimensional numerical simulations of Zeldovich pancake fragmentation in a dark matter dominated universe were carried out to study the hydrodynamical and gravitational effects on the formation of structures such as protogalaxies. Preliminary results were given in Yuan, Centrella and, Norman (1991). Here we report a more exhaustive study to

determine the sensitivity of protogalaxies to input parameters. The numerical code we used for the simulations combines the hydrodynamical code ZEUS-2D (Stone and Norman, 1992) which was modified to include the expansion of the universe and radiative cooling of the gas with a particle-mesh code which follows the motion of dark matter particles. The resulting hybrid code is able to handle highly nonuniform grids which we utilized to obtain a high resolution (much greater than 1 kpc) in the dense region of the pancake. Author

N93-26739*# Cambridge Univ. (England). Inst. of Astronomy.
DO GALACTIC POTENTIAL WELLS DEPEND ON THEIR ENVIRONMENT?
H. J. Mo and O. Lahav *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 70-71 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Using galaxies in complete samples as tracers of the galaxy density field and about 1000 galaxies with measured circular velocities as targets, we examine the cross-correlation functions between the targets and tracers as a function of galaxy circular velocities. The correlation strength does not vary with the circular velocities except for elliptical galaxies with the highest velocity dispersions, where the effect may well be due to morphological segregations in clusters of galaxies. This is contrasted with the strong dependence of the correlation functions of dark halos on their circular velocities in some models of galaxy formation. Author

N93-26740*# Harvard-Smithsonian Center for Astrophysics, Cambridge, MA.
THE EFFECT OF TIDAL FIELDS ON THE SHAPES AND KINEMATICS OF DARK HALOS
John Dubinski *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 72-73 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

We have carried out a series of N-body simulations to investigate the effect of tidal shear on the structure and kinematics of dark halos. We simulate the collapse of density perturbations using a tree code as described in Dubinski & Carlberg (1991). Density peaks are selected from a random realization of a CDM density field and used as the initial conditions for N-body simulations. We use an experimental approach to examine the effects of tidal shear on collapse. The cosmological tidal field is treated as an external time dependent potential whose strength and orientation can be varied freely. We examine the effects of the tidal field with two experiments. In the first experiment, we simulate a sample of 14 dark halos from the collapse of density peaks in the presence of a 1(sigma) tidal field. In the second experiment, we use the same initial conditions though the tidal field is turned off allowing an experimental control for comparison to highlight the influence of tidal shear on the development of the structure and kinematics of the dark halos. Author

N93-26741*# California Univ., Berkeley.
NEAR-IR IMAGING OF MODERATE REDSHIFT GALAXY CLUSTERS
S. A. Stanford, M. E. Dickinson, and P. R. M. Eisenhardt (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 74-75 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

We have obtained near-IR imaging of 3 moderate-z clusters on the 1.3 m at KPNO with SQIID, a new camera offering wide-field (5.5 arcmin) simultaneous JHK band imaging. Our photometry on a sample of approximately 100 likely member galaxies in one of the clusters, Abell 370 at z = 0.37, shows that we can obtain magnitudes good to 20 percent down to K = 18, considerably below the estimated K* = 16.5 at this redshift. These data indicate that there are no systematic problems in obtaining photometry at faint levels with SQIID. With the development of larger arrays, the field is open to progress. The resulting J, H, and K data for three clusters are combined with previously obtained multiband optical photometry. We present an investigation of the spectral properties and evolution of the dominant cold stellar populations by comparing optical-to-IR colors and color-magnitude diagrams to predictions from population synthesis models and galaxy spectral evolution codes. Derived from text

N93-26742*# Carnegie Institution of Washington, Pasadena, CA.
DISTANT RADIO GALAXIES IN THE NEAR IR
P. J. McCarthy, S. E. Persson, R. Elston, and P. R. M. Eisenhardt (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 76-77 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

We are carrying out a program of near IR imaging and spectroscopy of radio galaxies with redshifts of 1.5 and greater. One of its principal goals is to constrain the ages and star formation histories of massive galaxies at early epochs. The radio galaxies are drawn from the survey of 1Jy class sources by McCarthy et al (1989) and McCarthy (1990). The sample contains 18 radio galaxies with redshifts greater than 2 and an additional 10 objects with 1.5 less than z less than 2.0. The redshifts were obtained from long slit spectra with the CTIO 4 m. While the galaxies are quite faint (r approximately = 21-24.5) all have Lyman alpha emission with rest frame equivalent widths of 100 - 1000 A. Multicolor photometry in the g,r,i and J,H,K bands has been obtained with the 2.5-m Du Pont Telescope on Las Campanas and with the Hale 5 m telescope at Palomar. We have recently obtained near IR spectra, using the 4 m telescopes at KPNO and CTIO, of a few objects with the goal of determining the Lyman alpha/H-alpha ratio and hence the reddening. Author

N93-26743*# Carnegie Institution of Washington, Pasadena, CA.
EXTREMELY RED OBJECTS IN THE FIELDS OF HIGH REDSHIFT RADIO GALAXIES
S. E. Persson, P. J. McCarthy, Alan Dressler, and Keith Matthews (California Inst. of Tech., Pasadena.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 78-79 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

We are engaged in a program of infrared imaging photometry of high redshift radio galaxies. The observations are being done using NICMOS2 and NICMOS3 arrays on the DuPont 100-inch telescope at Las Campanas Observatory. In addition, Persson and Matthews are measuring the spectral energy distributions of normal cluster galaxies in the redshift range 0 to 1. These measurements are being done with a 58 x 62 InSb array on the Palomar 5-m telescope. During the course of these observations we have imaged roughly 20 square arcminutes of sky to limiting magnitudes greater than 20 in the J, H, and K passbands (3 sigma in 3 square arcseconds). We have detected several relatively bright, extremely red, extended objects during the course of this work. Because the radio galaxy program requires Thuan-Gunn gri photometry, we are able to construct rough photometric energy distributions for many of the objects. A sample of the galaxy magnitudes within 4 arcseconds diameter is given. All the detections are real; either the objects show up at several wavelengths, or in subsets of the data. The reddest object in the table, 9ab'B' was found in a field of galaxies in a rich cluster at z = 0.4; 9ab'A' lies 8 arcseconds from it. Author

N93-26744*# Canadian Inst. for Theoretical Astrophysics, Toronto (Ontario).
FAINT BLUE COUNTS FROM FORMATION OF DWARF GALAXIES AT z APPROXIMATELY EQUALS 1
Arif Babul and Martin J. Rees (Cambridge Univ., England.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 80-81 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

The nature of faint blue objects (FBO's) has been a source of much speculation since their detection in deep CCD images of the sky. Their high surface density argues against them being progenitors of present-day bright galaxies and since they are only weakly clustered on small scales, they cannot be entities that merged together to form present-day galaxies. Babul & Rees (1992) have suggested that the observed faint blue counts may be due to dwarf elliptical galaxies undergoing their initial starburst at z is approximately equal to 1. In generic hierarchical clustering scenarios, however, dwarf galaxy halos (M is approximately 10(exp 9) solar mass) are expected to form at an earlier epoch; for example, typical 10(exp 9) solar mass halos will virialize at z is approximately equal to 2.3 if the power-spectrum for the density fluctuations is that of the standard b = 2 cold dark matter (CDM) model. Under 'ordinary conditions' the gas would rapidly cool, collect in the cores, and undergo star-formation. Conditions at

high redshifts are far from 'ordinary'. The intense UV background will prevent the gas in the dwarf halos from cooling, the halos being released from their suspended state only when the UV flux has diminished sufficiently. Author (revised)

N93-26745*# Carnegie Institution of Washington, Pasadena, CA.
LOW SURFACE BRIGHTNESS GALAXIES AND TIDALLY TRIGGERED STAR FORMATION
Dennis Zaritsky and Stephen J. Lorrimer (Durham Univ., England.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 82-83 (For primary document see N93-26706 10-90)
(Contract NAS5-26555)
Avail: CASI HC A01/MF A04

Counts of companions to low surface brightness (LSB) galaxies are presented and these are compared to counts of companions to normal galaxies obtained with the same techniques and criteria. Our results are consistent with LSB's having no clustered companions and support the hypothesis that LSB galaxies have low star-formation rates because they lack external tidal triggering. Author (revised)

N93-26746*# Massachusetts Univ., Amherst.
MASSIVE LOW SURFACE BRIGHTNESS GALAXIES
Patricia M. Knezek and Stephen E. Schneider *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 84-85 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

A multi-wavelength study of an extreme type of galaxy which will assist us in our attempts to understand the formation and evolution of galaxies was completed. In particular, a subset of low surface brightness (bar-mu(sub B) is approximately greater than 25 mag arcsec(sup -2)), giant galaxies (LSBG's) which contain large amounts of atomic gas (M(HI) is approximately greater than 10(exp 10) solar mass), have blue optical diameters similar to those of giant spiral galaxies, but which do not seem to have prodigious amounts of ongoing star formation were observed. Our sample was drawn from the first and second Palomar Sky Surveys. This population of galaxies has been largely ignored because of selection effects which make it difficult to detect optically. The question of how these massive systems differ from the higher surface brightness 'normal' spiral galaxies is addressed. Using B and R surface photometry, in conjunction with H-alpha, HI, CO-12, and far-infrared data, an attempt is made to determine if these galaxies had an early epoch of star formation that has since faded, have ongoing star formation with an unusual interplanetary magnetic field (IMF), or are perhaps galaxies which have never efficiently formed stars due to a lack of molecular clouds. Author (revised)

N93-26747*# Astronomical Observatory, Uppsala (Sweden).
OXYGEN ABUNDANCES IN LOW SURFACE-BRIGHTNESS GALAXIES
Jari Roennback *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 86-87 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Recent theories predict that some protogalaxies, in low-density environments of the field, are contracting and interacting so slowly that global star formation can be delayed until today. These systems should be gas rich and have low surface-brightness. Blue compact galaxies (BCG's) and other compact HII region galaxies currently experiencing a burst of star formation are good candidates of truly young galaxies (in the sense that global star formation recently has been initiated). If they really are young, they ought to have a recent phase when their brightness was much lower than in the bursting phase. No claims of observations of such proto-BCG's exist. Observations of galaxies in their juvenile phases would undoubtedly be of great interest, e.g. the determination of the primordial helium abundance would improve. A proper place to search for young nearby galaxies could be among blue low surface-brightness galaxies (BLSBG's) in the local field. The study of low surface-brightness galaxies (LSBG's) as a group began relatively recently. They are galaxies with extraordinary properties both as individuals and as a group. A few years ago we started an optical study of a sample of BLSBG's selected from the ESO/Uppsala catalogue. Results of spectroscopic observations obtained on a subsample - 8 galaxies - of our selection are reported. The HII region oxygen chemical abundances and its relation to the blue absolute magnitude and surface-brightness is investigated. Derived from text

N93-26748*# Michigan Univ., Ann Arbor. Dept. of Astronomy.
CHEMICAL ABUNDANCES IN LOW SURFACE BRIGHTNESS GALAXIES: IMPLICATIONS FOR THEIR EVOLUTION
S. S. McGaugh and G. D. Bothun (Oregon Univ., Eugene.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 88-89 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Low Surface Brightness (LSB) galaxies are an important but often neglected part of the galaxy content of the universe. Their importance stems both from the selection effects which cause them to be under-represented in galaxy catalogs, and from what they can tell us about the physical processes of galaxy evolution that has resulted in something other than the traditional Hubble sequence of spirals. An important constraint for any evolutionary model is the present day chemical abundances of LSB disks. Towards this end, spectra for a sample of 75 H 2 regions distributed in 20 LSB disks galaxies were obtained. Structurally, this sample is defined as having B(0) fainter than 23.0 mag arcsec(sup -2) and scale lengths that cluster either around 3 kpc or 10 kpc. In fact, structurally, these galaxies are very similar to the high surface brightness spirals which define the Hubble sequence. Thus, our sample galaxies are not dwarf galaxies but instead have masses comparable to or in excess of the Milky Way. The basic results from these observations are summarized.
Derived from text

N93-26749*# Washington Univ., Seattle.
H II REGIONS IN THE DWARF GALAXY UGC-A 86
Bryan W. Miller and Paul Hodge *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 90-91 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

The uncertain nature of the dwarf irregular galaxy UGC-A 86 (VIIZw009) makes it a very interesting object for studying star formation at the low end of the galaxy luminosity function. Saha and Hoessel (1991) find that this object is composed of two main parts, one of which appears more resolved than the other. The more resolved component has an excess of blue stars, suggesting that it is currently undergoing star formation. Thus, they argue that UGC-A 86 could be either a superposition of unrelated galaxies, two interacting galaxies, or a single galaxy. However, surface photometry performed by Richter et al. (1991) indicates that it is a single galaxy with an exponential luminosity profile. Richter et al. also find UGC-A 86 to be extremely dusty and to be associated with the infrared source IRAS 3550+6657. The uncertainty is compounded by the large ambiguity in the distance, though a heliocentric H1 velocity of 80 plus or minus 7 km s(sup -1) suggests that it is either a member of the Local Group or perhaps the IC 342 group. A distance of 1.5 Mpc and a reddening of E(B - V) = 0.65 is adopted. UGC-A 86 in H-alpha was observed in order to measure its current star formation rate. This is part of a larger project to study the star formation rates and histories of a complete sample of dwarf galaxies in the Local Group and other nearby groups. The H region luminosity function and size distribution for UGC-A 86 are presented and compared with previous observations of similar dwarf galaxies. Derived from text

N93-26750*# Kapteyn Astronomical Lab., Groningen (Netherlands).
LOW SURFACE BRIGHTNESS GALAXIES
J. M. vanderHulst, W. J. G. deBlok, S. S. McGaugh (Michigan Univ., Ann Arbor.), and G. D. Bothun (Oregon Univ., Eugene.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 92-93 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

A program to investigate the properties of low surface brightness (LSB) galaxies involving surface photometry in U, B, V, R, I, and H-alpha, HI imaging with the Westerbork Synthesis Radio Telescope (WSRT) and the very large array (VLA) and spectrophotometry of H2 regions in LSB galaxies is underway. The goal is to verify the idea that LSB galaxies have low star formation rates because the local gas density falls below the critical density for star formation, and to study the stellar population and abundances in LSB galaxies. Such information should help understanding the evolutionary history of LSB galaxies. Some preliminary results are reported.
Author (revised)

N93-26751*# Toronto Univ. (Ontario).
A FAINT FIELD-GALAXY REDSHIFT SURVEY IN QUASAR FIELDS
Howard K. C. Yee and Erica Ellingson (Colorado Univ., Boulder.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 94-95 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Quasars serve as excellent markers for the identification of high-redshift galaxies and galaxy clusters. In past surveys, nearly 20 clusters of Abell richness class 1 or richer associated with quasars in the redshift range 0.2 less than z less than 0.8 were identified. In order to study these galaxy clusters in detail, a major redshift survey of faint galaxies in these fields using the CFHT LAMA/MARLIN multi-object spectroscopy system was carried out. An equally important product in such a survey is the redshifts of the field galaxies not associated with the quasars. Some preliminary results on field galaxies from an interim set of data from our redshift survey in quasar fields are presented. Derived from text

N93-26752*# Leiden Univ. (Netherlands).
CORRELATION BETWEEN LOW LEVEL FLUCTUATIONS IN THE X RAY BACKGROUND AND FAINT GALAXIES
Eline Tolstoy and R. E. Griffiths *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 99-100 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

A correlation between low-level x-ray fluctuations in the cosmic x-ray background flux and the large numbers of galaxies found in deep optical imaging, to m(sub v) is less than or equal to 24 - 26, is desired. These (faint) galaxies by their morphology and color in deep multi-color CCD images and plate material were optically identified. Statistically significant correlations between these galaxies and low-level x-ray fluctuations at the same positions in multiple deep Einstein HRI observations in PAVO and in a ROSAT PSPC field were searched for. Our aim is to test the hypothesis that faint 'star burst' galaxies might contribute significantly to the cosmic x-ray background (at approximately 1 keV). Author (revised)

N93-26753*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
THE HOT INTERSTELLAR MEDIUM IN NGC 1399
Michael Loewenstein and Peter J. Serlemitsos *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 101-103 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

The first two high signal-to-noise, broad bandpass x-ray spectra of elliptical galaxies were obtained with the Broad Band X-ray Telescope (BBXRT) as part of the December 1990 Astro mission. These observations provided unprecedented information on the thermal and metallicity structure of the hot interstellar media in two ellipticals: NGC 1399, the central galaxy in the Fornax cluster, and NGC 4472, the brightest galaxy in the Virgo cluster. The finalized analysis and interpretation of the approximately 4000 sec of BBXRT data on NGC 1399. Author (revised)

N93-26754*# Rensselaer Polytechnic Inst., Troy, NY.
ANALYSIS OF THE EINSTEIN SAMPLE OF EARLY-TYPE GALAXIES
Paul B. Eskridge and Giuseppina Fabbiano *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 104-105 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

The EINSTEIN galaxy catalog contains x-ray data for 148 early-type (E and SO) galaxies. A detailed analysis of the global properties of this sample are studied. By comparing the x-ray properties with other tracers of the ISM, as well as with observables related to the stellar dynamics and populations of the sample, we expect to determine more clearly the physical relationships that determine the evolution of early-type galaxies. Previous studies with smaller samples have explored the relationships between x-ray luminosity (L(sub x)) and luminosities in other bands. Using our larger sample and the statistical techniques of survival analysis, a number of these earlier analyses were repeated. For our full sample, a strong statistical correlation is found between L(sub X) and L(sub B) (the probability that the null hypothesis is upheld is P less than 10(exp -4) from a variety of rank correlation tests. Regressions with several algorithms yield consistent results. Derived from text

N93-26755*# Michigan Univ., Ann Arbor. Dept. of Astronomy.
SEARCHING FOR LYMAN ALPHA EMISSION FROM A POSSIBLE ZEL'DOVICH PANCAKE
Caroline Cox, Eric Schulman, and Joel N. Bregman *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 106-107 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

The detection of 2 x 10(exp 14) solar mass of neutral hydrogen at a redshift of 3.397 has been reported. Top-down theories of structure formation predict such a mass of hydrogen collapsing to form a protocluster of galaxies. We sought to observe this object in Lyman-alpha, which could be produced through ionization by the metagalactic ionizing radiation field or through internal ionization processes. On 29 Apr. 1992, the region of the reported HI emission for 1800 seconds with the 1.3 meter McGraw-Hill reflector at Michigan-Dartmouth-M.I.T. Observatory was observed. Because the H1 emission reported has a transverse scale of 300 sec, a 1/3.06 reducing camera and a Thomson CCD were used to obtain a field of view of about 600 sec by 840 sec. A filter 88 A wide, centered at 5354 A was used; Lyman-alpha emission at z = 3.4 is redshifted to 5347 A. In order to avoid saturating the CCD with a bright star in the field, nine 200 second exposures were taken. The combination of these images shows no obvious extended Lyman-alpha emission at a level of about 28 magnitudes per square arcsecond. The field observed also shows a distant cluster of galaxies. In order to determine if the cluster could in any way be associated with the cloud of neutral hydrogen at z = 3.4, we sought to estimate its redshift from the size and magnitude of the galaxies and of the cluster as a whole. Omega = 1 and H(sub O) = 50 km s(sup -1) Mpc(sup -1) were adopted; our redshift estimates range from z = 0.2 to z = 0.6. The cluster is clearly not associated with the HI cloud at z = 3.4.
Author (revised)

N93-26756*# Canadian Inst. for Theoretical Astrophysics, Toronto (Ontario).
CAN QUASARS PHOTOIONIZE THE INTERGALACTIC MEDIUM AT HIGH REDSHIFT?
Avery Meiksin and Piero Madau (Johns Hopkins Univ., Baltimore, MD.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 108-109 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

The reionization of the intergalactic medium (IGM) by quasar sources at high redshift are discussed. The integrated UV background from observed QSO's, taking into account the hydrogen opacity associated with intervening Ly-alpha clouds and Lyman limit systems are computed. It is noted that the published data appear to indicate a significant underdensity of absorption systems in the Ly-alpha forest with column densities N(sub HI) greater than 10(exp 15) cm(sup -2). This deficit results in a reduction of the opacity of the universe by a factor of 1.5-3 at z = 3-5 relative to previous estimates. The QSO contribution to the metagalactic flux at the Lyman edge may be as large as J(sub 912)(z) is approximately 6((1 + z)/4.5)(sup 0.5) x 10(exp -22) erg cm(sup -2) s(sup -1) Hz(sup -1) sr(sup -1) for q(sup o) = O, and slightly lower for q(sub o) = 1/2. For a density of the diffuse component of the IGM of omega(sub D)(h(sub 50)(sup 2)) less than 0.025, QSO's could photoionize a smooth IGM sufficiently to satisfy the constraints imposed by the Gunn-Peterson effect. The epoch of reionization could be as recent as z is approximately greater than 5. As a result, neutral patches of IGM would be detectable in the spectra of high redshift quasars. The patches would appear as absorption line systems with typical column densities of 10(exp 19) - 10(exp 20) cm(sup -2), and velocity widths of 100 - 1000 km s(sup -1). Author (revised)

N93-26757*# Cambridge Univ. (England). Inst. of Astronomy.
METAL ABUNDANCES AT z = 3.4
Andrew Cooke *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 110 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Echelle spectroscopy data were taken of the quasar 0000-263 on the 4m telescope at CTIO in Chile. Three nights of red and three nights of blue data were obtained (about four hours data per night). The resolution is typically 0.4 A at 5000 A (lamda/d(lamda) = 12500) and has good signal-to-noise over the wavelength range 4600 A to 8000 A. To keep the

statistics manageable the data were not rebinned, although the instrument was stable enough for each night's data on the object to be co-added. Arc spectra taken between each exposure were also co-added within the nights. During profile fitting the model was convolved with a Gaussian whose width was equal to nearby arc lines, so any broadening generated by the co-adding of data will not affect the final results. Since OI and HI have the same ionization potential (13.6 eV), (O/H) is approximately (OI/HI). Unfortunately, in this data only the 1302 A OI transition is visible, and it is blended with HI in the Lyman Alpha forest. However, OI and NI coexist (the ionization potential for NI is 14.5 eV) and so the NI triplet can constrain the redshift and turbulent width of the OI. When a fit was made to the regions containing OI and NI absorption three systems were apparent with similar redshifts and velocity widths. These three systems were fitted with tied redshifts and turbulent widths, while the other lines in the region were fitted as Lyman-Alpha. The saturated Lyman-Alpha profile was then fitted with three components at the same redshifts as these observed lines, with the line widths tied. Finally, metallicity ratios for the individual lines and their totals were calculated and compared to solar values. The results for the separate clouds from low to high redshift and for the total are presented. Author (revised)

N93-26758*# Michigan Univ., Ann Arbor. Dept. of Physics.
ENRICHMENT AND HEATING OF THE INTRACLUSTER MEDIUM BY EJECTION FROM GALAXIES
Chris Metzler and August Evrard *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 111-112 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Results of N-body + hydrodynamic simulations designed to model the formation and evolution of clusters of galaxies and intracluster gas are presented. Clusters of galaxies are the largest bound, relaxed objects in the universe. They are strong x-ray emitters; this radiation originates through thermal bremsstrahlung from a diffuse plasma filling the space between cluster galaxies, the intracluster medium or ICM. From observations, one can infer that the mass of the ICM is comparable to or greater than the mass of all the galaxies in the cluster, and that the ratio of mass in hot gas to mass in galaxies, M(sub ICM)/M(sub STARS), increases with the richness of the cluster. Spectroscopic studies of cluster x-ray emission show heavy element emission lines. While M(sub ICM)/M(sub STARS) is greater than or equal to 1 implies that most of the ICM is primordial in nature, the discovery of heavy elements indicates that some of the gas must have been processed through galaxies. Galaxy evolution thus directly impacts cluster evolution. Author (revised)

N93-26759*# Institut d'Astrophysique, Paris (France).
THE EVOLUTION OF THE INTERGALACTIC MEDIUM AND THE ORIGIN OF THE GALAXY LUMINOSITY FUNCTION Abstract Only
David Valls-Gabaud (Cambridge Univ., England.), Alain Blanchard (Observatoire de Paris-Meudon, France.), and Gary Mamon (Observatoire de Paris-Meudon, France.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 113 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

The coupling of the Press and Schechter prescription with the CDM scenario and the Hoyle-Rees-Ostriker cooling criterion leads to a galaxy formation scenario in which galaxies are overproduced by a large factor. Although star formation might be suppressed in the smaller halos, a large amount of energy per galactic mass is needed to account for the present number density of galaxies. The evolution of the intergalactic medium (IGM) provides a simple criterion to prevent galaxy formation without requiring feedback, since halos with small virial temperatures are not able to retain the infalling hot gas of the IGM. If the ionizing background has decreased since z is approximately 1 - 2, then this criterion explains the slope of the luminosity function at the faint end. In addition, this scenario predicts two populations of dwarf galaxies, well differentiated in age, gas content, stellar populations, and clustering properties, which can be identified with dE and dIm galaxies. Author (revised)

N93-26760*# Institut d'Astrophysique, Paris (France).
EVIDENCE FOR A MULTIPHASE, INHOMOGENEOUS INTERSTELLAR MEDIUM IN DAMPED Ly ALPHA SYSTEMS Abstract Only
David Valls-Gabaud (Cambridge Univ., England.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 114 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

The large optical depth in absorption of the Ly-alpha line in damped Ly-alpha systems implies that the emission line produced by H2 regions is very broad, since the number of diffusions is very large. The emission lines observed in DLy-alpha systems are narrow, a fact that can only be explained if the emission comes from the outer layers alone, or if the interstellar medium (ISM) is clumpy and multiphase. It is shown how discrete, cold H1 clouds embedded in a hot, fully ionized phase, produce narrow lines. This might provide evidence for a supernova remnant SNR-dominated ISM at high redshift, in agreement with the observed metallicity and chemical evolution models. Other high redshift galaxies also offer evidence for such a multiphase, in homogeneous ISM. Author (revised)

N93-26761*# Colorado Univ., Boulder. Center for Astro-Physics and Space Astronomy.
HST/FOS SPECTRA OF PG 1351+64: AN INTRINSIC ABSORBER AT LOW REDSHIFT
Arno Granados, Elise Sachs, J. Michael Shull, and John T. Stocke *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 115-116 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

A 1 A resolution spectra of the nearby (z = 0.08797) Seyfert galaxy PG 1351+64 taken with the Faint Object Spectrograph (FOS) onboard the Hubble Space Telescope is presented. Spectral coverage runs from 1200-3200 A in the observed frame and includes emission and absorption features due to Ly-alpha, N 5, Si 4, C 4, and Mg 2. Three distinct intrinsic absorption systems in Ly-alpha, N 5, Si 4, and C 4, and tentatively in Mg 2, at velocities of 900 km/s, 1630 km/s, and 2900 km/s (plus or minus 100 km/s) relative to the emission-line redshift of the QSO were detected. The maximum relative velocity of these absorbers is less than 5000 km/s and therefore does not meet Weymann, Carswell, & Smith's criteria for Broad-Absorption-Line (BAL) QSO's at high-z. However, the absorptions are almost certainly intrinsic to the QSO given the low redshift of this object. In addition, PG 1351+64 is marginally radio-quiet, as are all BALQSO's, based on recent estimates of the radio-loud/radio-quiet dividing line. The narrow velocity width, less than 500 km/s, and low outflow velocities of the absorption systems are more similar to so called 'associated absorbers' seen at high-z in radio-loud quasars, but whose absorptions are thought to arise in clouds much farther from the nucleus (greater than 1 kpc) than are BAL clouds (1-10 pc). Despite the qualitative resemblance to the associated absorbers, the absorption systems in PG 1351+64 appear to be the low-luminosity analogs of BALQSO absorption troughs. The lower observed outflow velocities in PG 1351+64 are due to the much lower luminosity of the nuclear source in comparison to the high-z, high-luminosity BALQSO's. In addition, 'satellite' emission lines displaced 4000-5000 km/s blueward and redward of the Mg 2 emission were discovered.
Derived from text

N93-26762*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
LOW REDSHIFT LYMAN ALPHA ABSORPTION LINES AND THE DARK MATTER HALOS OF DISK GALAXIES
Philip Maloney *In its* The Evolution of Galaxies and Their Environment Jan. 1993 p 117-118 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Recent observations using the Hubble Space Telescope of the z = 0.156 QSO 3C 273 have discovered a surprisingly large number of Ly-alpha absorption lines. In particular, Morris et al. found 9 certain and 7 possible Ly-alpha lines with equivalent widths above 25 mA. This is much larger (by a factor of 5-10) than the number expected from extrapolation of the high-redshift behavior of the Ly-alpha forest. Within the context of pressure-confined models for the Ly-alpha clouds, this behavior can be understood if the ionizing background declines sharply between z is approximately 2 and z is approximately 0. However, this requires that the ionizing photon flux drop as rapidly as the QSO volume emissivity; moreover, the absorbers must have a space density n(sub O) is approximately 2.6(N/10)h/((D/100 kpc)(sup 2)) Mpc(sup -3) where D is the present-day diameter of the absorbers. It is somewhat surprising that such necessarily fragile objects could have survived in such numbers to the present day. It

is shown that it is plausible that the atomic hydrogen extents of spiral and irregular galaxies are large enough to produce the observed number of Ly-alpha absorption lines toward 3C 273, and that the neutral column densities and doppler b-values expected under these conditions fall in the range found by Morris et al. (1991). Author (revised)

N93-26763*# Pittsburgh Univ., PA.
NEUTRAL HYDROGEN AT THE PRESENT EPOCH: A CONSTRAINT ON THE EVOLUTION OF HIGH REDSHIFT SYSTEMS
Sandhya Rao and Frank H. Briggs *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 119-120 (For primary document see N93-26706 10-90)
(Grants NSF AST-87-15070; NSF AST-91-19930)
Avail: CASI HC A01/MF A04

Damped Lyman-alpha and metal absorption lines in the spectra of quasars indicate the presence of intervening gas-rich systems at high redshift (z greater than 2). These systems have characteristic size scales, velocity dispersions, and neutral hydrogen column densities (N(H1)) similar to present day spirals and are thus thought to be their progenitors. Constraints on galaxy evolution can be derived by comparing the H1 properties of high redshift systems to the present galaxy population. Good observational statistics on high redshift absorbers specify the number of these systems along the line of sight as a function of N(H1), the column density of neutral hydrogen per absorber. Similar statistics for nearby (z = 0) galaxies of which spirals are the only gas-rich systems that provide a significant cross-section for the interception of light from quasars is derived.
Author (revised)

N93-26764*# Canadian Inst. for Theoretical Astrophysics, Toronto (Ontario).
TESTING THE PRESSURE-CONFINED Ly ALPHA CLOUD MODEL
Arif Babul and Gerard M. Williger (Cerro Tololo Inter-American Observatory, La Serena, Chile.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 121-122 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

The Ly-alpha absorption line forest, seen in quasar spectra, is generally interpreted as being due to cosmologically distributed 'clouds' of primordial gas. Analyses of the observations reveal that the number distribution can be described by power laws: dN/dz is proportional to (1 + z)(sup gamma) and dN/dN(sub HI) is proportional to N(sub HI)(sup -beyda), where N(sub HI) is the HI column density. The typical values for power law indices range between 2 is approximately less than gamma is approximately less than 2.6 and 1.7 is approximately less than gamma is approximately less than 1.9. One model postulates that the Ly-alpha clouds are optically thin entities, photoionized by the background UV flux, J(sub nu) is proportional to (1 + z)(sup j), and confined by an adiabatically evolving intercloud medium (ICM): P(z) is proportional to (1 + z)(sup 5). Analytic studies of this model suggest that the ensuing Ly-alpha line statistics can account for the observations (in particular, the dN/dz and the dN/dN(sub HI) distributions) if the cloud mass spectrum is a power law dN/dN is proportional to M(sup -delta), delta is approximately 1.9, and j is approximately 4. One of the simplifying assumptions incorporated into these studies is the existence of a large mass range for the clouds at all epochs, the validity of which is questionable. The pressure-confined model is investigated using a 1-D spherically symmetric hydrodynamical code to simulate cloud evolution over the epoch 1.8 less than z less than 6. This enables us to relax many of the assumptions incorporated in the analytic studies. Author (revised)

N93-26765*# Tokyo Astronomical Observatory, Mitaka (Japan). Div. of Theoretical Astrophysics.
ON THE EVOLUTION OF LYMAN ALPHA CLOUDS BASED UPON THE MINIHALO MODEL
Izumi Murakami and Satoru Ikeuchi *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 123-124 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Intergalactic clouds confined by the gravity of cold dark matter (CDM), the so called mini-halo, is considered. Assuming a simplified evolution law of UV flux and mass function of gas clouds, number density evolution and H1 column density distribution can be reproduced by mini-halo model. Considering interaction between supersonic flow and a mini-halo, spatial correlation and the proximity effect of Ly-alpha forest can be investigated.
Author (revised)

N93-26766*# San Diego Univ., CA. Center for Astrophysics and Space Sciences.
PROBING THE EXTENT AND CONTENT OF LOW IONIZATION GAS IN GALAXIES: QSO ABSORPTION AND HI EMISSION
Donna S. Womble *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 125-126 (For primary document see N93-26706 10-90)
(Contract NAS5-29293; NAG5-1630)
Avail: CASI HC A01/MF A04

The small projected separations of some QSO's and low-redshift galaxies provide unique opportunities to study the extent and content of gas in galaxies through observation of absorption in the QSO spectra. Observations of these systems provide valuable information on the connection between the absorbing gas and the galaxy, as well as detailed information on the morphology and environment of the galaxy itself. While there is direct evidence that galaxies can produce the intervening-type QSO absorption lines, over the past decade, the study of such 'QSO-galaxy pairs' (at low redshift) has been considered unsuccessful because new detections of absorption were seldom made. A fundamental problem concerning the relation between these low-redshift systems and those seen at moderate to high redshift remains unresolved. Direct and indirect measures of galaxy absorption cross sections at moderate to high redshifts (z is approximately greater than 20.5) are much larger than the optical and HI sizes of local galaxies. However, direct comparison of the low and moderate to high redshift systems is difficult since different ions are observed in different redshift regimes. Observations are presented for a new sample of QSO-galaxy pairs. Nine new QSO's which shine through nearby galaxies (on the sky-plane) were observed to search for CaII absorption in the QSO spectra at the foreground galaxy redshifts. Derived from text

N93-26767*# Colorado Univ., Boulder. Center for Astro-Physics and Space Astronomy.
THE TWO-POINT CORRELATION FUNCTION OF RANDOMLY DISTRIBUTED LYMAN ALPHA CLOUDS
Mark A. Fardal and J. Michael Shull *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 127-128 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

It is often assumed that Ly-alpha forest clouds are randomly distributed, intergalactic objects that are highly ionized by the UV background produced by quasars. If these assumptions are true, fluctuations in the UV background should produce a nonzero two point correlation function in the Ly-alpha forest. This effect, which is really just a generalization of the proximity effect, is more significant at high redshift (z is approximately 3-4) because the mean free path for UV photons is smaller there, and the fluctuations correspondingly larger. This effect was studied using both the semi-analytic techniques of Zuo's recent papers and Monte Carlo simulations. The correlation function is expected to have a small yet potentially measurable amplitude that is consistent with current upper limits. Furthermore, the signature of this effect is distinctive because the nonzero correlation function extends over the photon mean free path, which is larger than the expected scale of large-scale structure. Observations or upper limits on this effect could provide information about the source of the ionizing background at high redshifts and the nature of the Ly-alpha forest clouds.
Derived from text

N93-26768*# California Inst. of Tech., Pasadena. Dept. of Astronomy.
INTENSITY CORRELATION OF IONIZING BACKGROUND AT HIGH REDSHIFTS
Lin Zuo (Canadian Inst. for Theoretical Astrophysics, Toronto, Ontario.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 129-130 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Intensity correlation of ionizing background at high redshifts is discussed. The intensity correlation function xi(sub j) and the absorption line equivalent width correlation xi(sub 1/W) are discussed. CASI

N93-26769*# Chicago Univ., IL. Dept. of Astronomy and Astrophysics.
CONSTRAINTS ON CHEMICAL EVOLUTION MODELS FROM QSOALS ABUNDANCES
J. T. Lauroesch *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 131-132 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Models of the formation and early chemical evolution of our Galaxy are guided and constrained by our knowledge of abundances in globular cluster stars and halo field stars. The abundance patterns identified in halo and disk stars should be discernible in absorption lines of gas clouds in forming galaxies which are accidentally lying in front of background QSO's. Conversely, the ensemble of QSO absorption line systems (QSOALS) at each redshift may suggest a detailed model for the formation of our Galaxy that is testable using abundance patterns in halo stars. Author

N93-26770*# Space Telescope Science Inst., Baltimore, MD.
INTERSTELLAR Mg II AND C IV ABSORPTION BY 1 1/2 GALAXIES ALONG THE SIGHTLINE TO MrK 205
David V. Bowen and J. Chris Blades *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 133-134 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

The first results of our HST survey designed to search for Mg 2 and C 4 absorption lines from the disks and halos of low-redshift galaxies using background QSO's and supernovae as probes are presented. Our survey utilizes the high resolution of the Goddard High Resolution Spectrograph enabling us to calculate the column densities and doppler parameters of individual components within an absorption complex, and hence determine the physical conditions of the absorbing gas. Observing the complexity of the absorption line profiles i.e., the velocity distribution and total velocity extent of the constituent components, offers an important description of the kinematics of the absorbing gas, and hence an understanding of its origin. Focus is on one sight line in particular, that towards Mrk 205, which passes 3-5 kpc from the intervening galaxy NGC 4319. Mg 2 and C 4 absorption from both local Milky Way halo gas and from NGC 4319 is detected. Derived from text

N93-26771*# Texas Univ., Austin.
THE REIONIZATION OF THE UNIVERSE: THE FEEDBACK OF GALAXY FORMATION ON THE INTERGALACTIC MEDIUM
Paul R. Shapiro and Mark L. Giroux *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 136 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

The thermal and ionization evolution of a uniform intergalactic medium (IGM) composed of H and He, undergoing reionization, including the mean effect of gas clumps embedded in a smoothly distributed ambient gas were calculated. The rate equations for ionization and recombination were solved together with the equations of energy conservation, including the effects of cosmological expansion, radiative and Compton cooling, and the diffuse flux emitted by the gas, and radiative transfer. The contribution to the continuum opacity of the universe due to the observed quasar absorption line clouds (QALC'S) were included. A variety of sources of photoionization, including quasars and primeval galaxies, as well as the possibility that hydrodynamical processes deposit thermal energy in the IGM were considered. Applications of these calculations including the evolution of the Ly-alpha forest clouds are described. A self-consistent treatment of the thermal and ionization history of the intergalactic medium (IGM) must take account of the growth of structure in the universe, since the mean density of the IGM corresponds primarily to the time-varying uncollapsed fraction of the baryon-electron component of the matter, and the collapsed fraction, in turn, can have a feedback effect on this uncollapsed fraction by releasing ionizing radiation and thermal energy and by contributing to the opacity of the universe. The coupled evolution of the IGM and the emerging structure with a special focus on the reionization of the IGM, which is believed to have been completed by some redshift z is approximately greater than 4, as inferred from the absence of the Gunn-Peterson effect in the spectra of high z quasars, are studied. The results and implications of detailed, numerical calculations of the thermal and ionization balance and radiative transfer in a uniform IGM of H and He, including the mean effect of an evolving distribution of gas clumps embedded in a smoothly distributed ambient gas is described. Author (revised)

N93-26772*# Tokyo Astronomical Observatory, Mitaka (Japan).
IONIZATION STATES OF METALLIC ABSORPTION-LINE SYSTEMS IN CONTINUA OF QUASARS
Kiyomi Denda and Satoru Ikeuchi *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 137-138 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Ionization states of metallic absorption-line systems in continua of quasars (QSO's) are studied, assuming that the metallic lines arise in gaseous halos of high-redshift galaxies in photoionization equilibrium under the background UV radiation, and constraints on the intensity and spectral shape of the UV radiation are obtained. Then a structure of absorbers suitable for all of the metallic absorption line systems are discussed. Author (revised)

N93-26773*# Arizona Univ., Tucson. Steward Observatory.
ABSORPTION SPECTRA OF Q 0000-263 AND Q 1442+101
B. L. Frye, J. Bechtold, L. A. Moustakas, and A. Dobrzycki (Harvard-Smithsonian Center for Astrophysics, Amado, AZ.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 139-140 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Studying the Lyman-alpha forest allows us to trace the cosmological distribution of matter through time, and may reveal insights into important questions such as the onset of galaxy formation. An equation for determining the number of Lyman-alpha absorption lines per redshift per rest equivalent in the Lyman-alpha forest is given. For a nonevolving population of clouds gamma = 1 for q(sub 0) = 0, and gamma = 0.5 for q(sub 0) = 0.5. A detailed study of the Lyman-alpha forests of Q 1442+101 at z(sub em) = 3.54 and Q 0000-263 at z(sub em) = 4.11. Author (revised)

N93-26774*# Chicago Univ., IL. Dept. of Astronomy and Astrophysics.
PRUNING THE LYMAN ALPHA FOREST OF Q1331+170
Varsha P. Kulkarni and Donald G. York *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 141-142 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

A multitude of absorption lines seen shortward of QSO Ly-alpha emission, that cannot be traced to heavy element absorption systems, are assumed to be Ly-alpha lines arising in intervening clouds. Studies of these Ly-alpha clouds, typically done at 1 A or lower resolution, have shown N(H1) approximately equal to 10(exp 13) - 10(exp 17) sq cm and b approximately equal to 35 km/s. Sargent et al 1980, on the basis of a flat pair velocity correlation function (PVCF), argued that these clouds are intergalactic. But Crotts 1989 showed that the strong Ly-alpha lines are spatially clustered. High resolution studies of Webb 1987 and Rauch et al 1992 also report some evidence for weak clustering, but overall such high resolution studies have been rare. A study of the Ly-alpha forest of Q1331 + 170 over x(sub abs) = 1.60 - 2.19 based on 18 km/s resolution data at S/N approximately equal to 15, with metal-line deblending incorporated. Author (revised)

N93-26775*# Cambridge Univ. (England). Inst. of Astronomy.
A RE-ANALYSIS OF THE SPECTRUM OF 2206-199
M. Rauch, R. F. Carswell, J. K. Webb (New South Wales Univ., Kensington, Australia.), and R. J. Weymann (Carnegie Institution of Washington, Pasadena, CA.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 143-144 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Recently Pettini, Hunstead, Smith and Mar, (PHSM 1991) performed an analysis of the Ly-alpha forest of QSO 2206-199N at very high resolution. On the basis of their observations they concluded that most Doppler parameters b = (square root of 2)(sigma) of Ly-alpha forest lines are below 22 km/s, with a range down to a few km/s and a median of 17 km/s. They also found a strong intrinsic correlation between Doppler parameter b and column density N. These results are in contrast to those of a similar study by Carswell, Lanzetta, Parnell, and Webb (CLPW 1991) at comparable resolution with the same instruments, who find that most of

the Ly-alpha lines towards QSO 1100-264 have Doppler parameters above 15 km/s (median b = 34 km/s), and that there is no significant correlation between b and N. Whilst an intrinsic difference between the lines of sight to 2206-199 and to other QSO's can not be excluded a priori, previous disagreement between Doppler parameter estimates obtained by both groups pointed to a potential difference in estimation techniques and in the interpretation of the results. To investigate this possibility, the AAT/UCLES spectrum of 2206-199 obtained by PHSM were reanalyzed. The spectrum was extracted from the raw data and determined the line parameters using the method described by CLPW. Derived from text

N93-26776*# Colorado Univ., Boulder. Center for Astro-Physics and Space Astronomy.

IRAS STUDIES OF GALACTIC SUPERSHELLS

Jon M. Saken, J. Michael Shull, and Robert A. Fesen (Dartmouth Coll., Hanover, NH.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 145-146 (For primary document see N93-26706 10-90)

Avail: CASI HC A01/MF A04

Using IRAS Skyflux images and a new catalog of OB stars in the Cygnus region, a complete infrared supershell surrounding the Cyg OB1 Association was identified. This supershell is seen as a conspicuous, well-defined 2 deg x 5 deg region deficient of IR emission, with a limb-brightened edge and dimensions of about 50 x 130 pc at 1.5 kpc. The shell's elongated morphology is consistent with OB-star subclustering over the approximately 10(exp 6) yr age of the bubble. With a parent star cluster still visible (10 O stars between 25 and 45 solar mass, 3 - 4 Wolf-Rayet stars, and the possibility of 3 - 5 more massive stars that died as supernovae) the Cyg OB1 supershell is an excellent object for studying the formation and evolution of Galactic supershells. A discrepancy between the less than or equal to 1 Myr bubble age estimated from its size and the 5 Myr cluster turnoff age (45 solar mass) may require non-coeval massive star formation to explain the number of post-main-sequence stars and limit the number of past supernovae. Derived from text

N93-26777*# New Mexico Univ., Albuquerque. Inst. for Astrophysics.

STARBURST AGES IN HII GALAXIES

Hans-Joerg Deeg (National Radio Astronomy Observatory, Socorro, NM.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 147-148 (For primary document see N93-26706 10-90)

Avail: CASI HC A01/MF A04

The age of the starbursts of a few H2 galaxies is derived from optical photometry and compared with previous results from radio continuum spectra. H2 galaxies are gas rich and characterized by the dominance of giant H2 regions, blue stellar colors, high surface brightness, and narrow emission lines. The presently observed high abundances of bright young stars must be the result of a recent -or even ongoing- starburst. The question, whether the observed starburst is the first one or if it is a recurrent phenomenon, is still open. If the starburst is the first one, H2 galaxies can be interpreted as being among the most unevolved galaxies known - their star formation characteristics possibly paralleling that of normal galaxies early in their evolution. A sample of five H2 galaxies was observed with B, R, and I broadband filters. They have been observed previously at several radio continuum frequencies. The photometric data are given. The results of the photometry and a comparison with radio continuum spectra are given. Derived from text

N93-26778*# Harvard-Smithsonian Center for Astrophysics, Cambridge, MA.

STARBURST MODELS OF MERGING GALAXIES

Andrea H. Prestwich *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 149-150 (For primary document see N93-26706 10-90)

Avail: CASI HC A01/MF A04

In the past decade, infrared observations have shown that interacting and merging galaxies have higher luminosities than isolated systems, with the luminosities in mergers as high as 10(exp 12) solar luminosity. However, the origin of the luminosity found in mergers is controversial, with two main competing theories. The first is the starburst scenario. As two gas rich galaxies start to merge, cloud-cloud collisions induce fast shocks in the molecular gas. This gas cools, collapses, and fragments, producing a blast of star formation. The main rival to this theory is that the infrared luminosity is produced by a dust embedded active nucleus, the merger of two gas rich galaxies providing the 'fuel to feed the monster'. There has even been speculation that there is an evolutionary link between starbursts and active nuclei, and that possibly active galactic nuclei (AGN's) and QSO's were formed from a starburst. Assuming that the infrared luminosity in merging galaxies is due to star formation, there should be ionizing photons produced from the high mass stars, giving rise to recombination line emission. The objective is to use a simple starburst model to test the hypothesis that the extreme infrared luminosity of merging galaxies is due to a starburst. Author (revised)

N93-26779*# Consejo Superior de Investigaciones Cientificas, Tenerife (Spain).

THE EFFECT OF MASSIVE STARS ON THE IONIZED MEDIUM OF EXTRAGALACTIC HII REGIONS

Hector O. Castaneda (Roque de los Muchachos Observatory, La Laguna, Spain.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 151-152 Sponsored in part by CICYT (For primary document see N93-26706 10-90)

Avail: CASI HC A01/MF A04

Giant extragalactic H2 regions (GEHR) are centers of active star formation, ionized by populous clusters of OB stars. These objects are characterized by their low electron density, linear dimensions of order of 10(exp 2) - 10(exp 3) pc, varied morphology, and inhomogeneous distribution of the gas. They are ideal laboratories to study the processes of interaction between the gas and the stars, that could then be extended to the study of H2 and starburst galaxies. An observational program on a selected group of giant H2 regions with the use of one- and two-dimensional spectroscopy is being conducted. Our aim is two-fold: to understand the internal structure of the regions and to study the kinematics and dynamics of the ionized gas. A short report of our ongoing research is presented. Author (revised)

N93-26780*# California Univ., Santa Cruz. Board of Studies in Astronomy and Astrophysics.

GAS DISTRIBUTION AND STARBURSTS IN SHELL GALAXIES

Melinda L. Weil and Lars Hernquist *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 153-154 (For primary document see N93-26706 10-90)

Avail: CASI HC A01/MF A04

Detailed maps of most elliptical galaxies reveal that, whereas the greatest part of their luminous mass originates from a smooth distribution with a surface brightness approximated by a de Vaucouleurs law, a small percentage of their light is contributed by low surface brightness distortions termed 'fine structures'. The sharp-edged features called 'shells' are successfully reproduced by merger and infall models involving accretion from less massive companions. In this context, dwarf spheroidal and compact disk galaxies are likely progenitors of these stellar phenomena. However, it is probable that the sources of shell-forming material also contain significant amounts of gas. This component may play an important role in constraining the formation and evolution of shell galaxies. To investigate the effects of the gaseous component, numerical simulations were performed to study the tidal disruption of dwarf galaxies containing both gas and stars by more massive primaries, and the evolution of the ensuing debris. The calculations were performed with a hybrid N-body/hydrodynamics code. Collisionless matter is evolved using a conventional N-body technique and gas is treated using smoothed particle hydrodynamics in which self-gravitating fluid elements are represented as particles evolving according to Lagrangian hydrodynamic equations. An isothermal equation of state is employed so the gas remains at a temperature 104 K. Owing to the large mass ratio between the primary and companion, the primary is modeled as a rigid potential and the self-gravity of both galaxies is neglected. Derived from text

N93-26781*# Indian Inst. of Science, Bangalore.

STARBURSTS TRIGGERED BY CENTRAL OVERPRESSURE IN INTERACTING GALAXIES

Chanda J. Jog and Mousumi Das *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 155-156 (For primary document see N93-26706 10-90)

Avail: CASI HC A01/MF A04

A triggering mechanism for the origin of enhanced, massive-star formation in the central regions of interacting spiral galaxy pairs is proposed. Our mechanism is based on the detailed evolution of a realistic interstellar medium in a galaxy following an encounter. As a disk giant molecular cloud (GMC) tumbles into the central region following a galaxy encounter, it undergoes a radiative shock compression via the pre-existing high pressure of the central intercloud medium. The shocked outer shell of a GMC becomes gravitationally unstable and begins to fragment thus resulting in a burst of star formation, when the growth time for the gravitational instabilities in the shell becomes smaller than the crossing time of the shock. The resulting values of typical infrared luminosity agree with observations. Author (revised)

N93-26782*# California Univ., Los Angeles.
FEEDING IC 342: THE NUCLEAR SPIRAL OF A STARBURST GALAXY
D. Levine, J. L. Turner, and Robert L. Hurt *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 157-158 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

IC 342 is a large nearby (1.8 Mpc, Turner and Hurt, 1991, hereafter T&H) spiral galaxy undergoing a moderate nuclear starburst. T&H have previously mapped the inner arcminute in CO-13(1-0) using the Owens Valley Millimeter Interferometer and found evidence that the nuclear molecular gas takes the form of spiral arms in a density wave pattern. They suggest that radial streaming along the arms may channel gas from the exterior of the galaxy into the nucleus, feeding the starburst. We have mapped the CO-12(1-0) emission of the inner 2 kpc of IC 342 at 2.8 inch resolution using the Owens Valley Radio Observatory (OVRO) Millimeter Interferometer. The greater sensitivity of CO-12 observations has allowed us to trace the spiral pattern out to a total extent of greater than 1 kpc. The CO-12 observations extend considerably the structure observed at CO-13 and offer further evidence that a spiral density wave may extend from the disk into the nucleus of IC 342. Author

N93-26783*# Max-Planck-Inst. fuer Extraterrestrische Physik, Garching (Germany).
OBSERVATIONS OF THE CO J=6-5 TRANSITION IN STARBURST GALAXIES
A. I. Harris (Hawaii Univ., Hilo.), R. E. Hills (Cambridge Univ., England.), J. Stutzki (Cologne Univ., Germany.), U. U. Graf (Texas Univ., Austin.), A. P. G. Russell (Royal Observatory, Edinburgh, Scotland.), L. J. Tacconi (Hawaii Univ., Hilo.), and R. Genzel (Hawaii Univ., Hilo.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 159-160 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Over the past several years, short-submillimeter observations of carbon monoxide's (CO) mid-J rotational levels have revealed the presence of a large amount of excited molecular gas in luminous giant molecular clouds in our Galaxy. Submillimeter lines are specific probes of excited material: collisional excitation of the level energy of 116 K above ground, and 6-5 transition's critical density is approximately 10(exp 6) cm(exp -3) in optically thin gas. Radiative trapping effects reduce the excitation requirements to some extent, but detection of the CO J=6-5 line is nearly indisputable proof of the existence of gas that is both warm and dense. The excitation conditions also imply that cool (T less than 20 K) molecular clouds within the beam neither emit nor absorb in the short-submillimeter lines; in our Galaxy, clouds with active massive star formation emit the strongest short-submillimeter CO rotational lines. We used these properties to explore the distribution of excited molecular material and physical conditions within the star formation regions of several classical starburst nuclei: NGC253, M82, and IC342. We have used the 6-5 transition as a thermometer of warm molecular gas in starburst nuclei, unambiguously finding that the nuclear molecular gas in starburst galaxies is substantially warmer than in typical disk clouds. CASI

N93-26784*# Institut d'Astrophysique, Paris (France).
THE LYMAN ALPHA EMISSION OF STARBURST GALAXIES Abstract Only
David Valls-Gabaud (Cambridge Univ., England.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 161 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Nearby starburst galaxies have consistently shown anomalous Ly-alpha/H-beta ratios. It has been suggested that dust, associated with resonant scattering, quenches the Ly-alpha line by a large factor. However, the observed amount of dust can barely account for the large depletion factors. It is proposed here that a much more important effect is the age of the burst. Normal (i.e., case B recombination) ratios are observed if the galaxy is currently undergoing the burst, while anomalous ratios appear when the galaxy is observed in the post-burst phase. Underlying stellar populations in the UV spectra should therefore be older in the latter case. This scenario explains the presence of Ly-alpha in absorption. Implications for deep surveys are also discussed. Author

N93-26785*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
ULTRAVIOLET IMAGING TELESCOPE (UIT) OBSERVATIONS OF GALAXIES Abstract Only
S. G. Neff *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 162 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Ultraviolet images of several galaxies were obtained during the ASTRO-1 shuttle mission in December, 1990. The images have a FWHM angular resolution of approximately 3 arcsecond and are of circular fields approximately 40 arcminutes in diameter. Most galaxies were observed in at least two and sometimes as many as four broad bands. A very few fields were observed with narrower band filters. The most basic result of these observations is that most systems look dramatically different in the UV from their well-known optical appearances. Preliminary results of these studies will be presented. Information will be available on fields observed by the UTI during the ASTRO 1 mission; when that data becomes public it can be obtained from the NSSDC. The ASTRO observatory is expected to fly again in 1994 with approximately half of the observing time from that mission devoted to guest observers. The Ultraviolet Imaging telescope is extremely well suited for galaxy studies, and the UIT term is interested in encouraging a wide range of scientific studies by guest observers. Ultraviolet Imaging telescope is extremely well suited for galaxy studies, and the UIT team is interested in encouraging a wide range of scientific studies by guest observers. Derived from text

N93-26786*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
EVOLUTION OF LUMINOUS IRAS GALAXIES: RADIO IMAGING
S. G. Neff and J. B. Hutchings (Dominion Astrophysical Observatory, Victoria, British Columbia.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 163 Submitted for publication (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

In a recent study of IRAS galaxies' optical morphologies, we found that luminous IR sources lie in the IR color-luminosity plane in groups which separate out by optical spectroscopic type and also by degree of tidal disturbance. We found that the most luminous steep-IR-spectrum sources are generally galaxies in the initial stages of a major tidal interaction. Galaxies with active nuclei were generally found to have flatter IR spectra, to cover a range of IR luminosity, and to be in the later stages of a tidal interaction. We proposed a sequence of events by which luminous IR sources evolve: they start as interacting or merging galaxies, some develop active nuclei, and most undergo extensive star-formation in their central regions. Another way to study these objects and their individual evolution is to study their radio morphologies. Radio emission may arise at a detectable level from supernovae in star-forming regions and/or the appearance of an active nucleus can be accompanied by a nuclear radio source (which may develop extended structure). Therefore, the compact radio structure may trace the evolution of the inner regions of IRAS-luminous sources. If the radio sources are triggered by the interactions, we would expect to find the radio morphology related to the optical 'interactivity' of the systems. Here, we explore using the radio emission of IRAS galaxies as a possible tracer of galaxy evolution. We present and discuss observations of the compact radio morphology of 111 luminous IRAS-selected active galaxies covering a wide range of IR and optical properties. Author

N93-26787*# California Univ., Berkeley.
OB ASSOCIATIONS AND GIANT MOLECULAR CLOUDS IN THE GALAXY
Jonathan Williams and Chris McKee *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 167 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Giant molecular clouds (GMC's) are the sites of all OB star formation in the Galaxy. These OB stars typically form in large associations and photoionize the surrounding gas, eventually destroying the clouds from which they were born. CO surveys have revealed the distribution of GMC's in the Galaxy, and radio observations provide data on the distribution of associations. These results are extrapolated to determine Galactic mean distribution functions of each and then combined to determine how GMC's and OB associations are correlated. The resulting probability distribution of luminosity given cloud mass implies that although most of the molecular mass of the Galaxy is in massive star forming complexes, a large number of clouds above which massive star formation is extremely likely and abundant and below which it is almost certainly absent. Derived from text

N93-26788*# Ritter Observatory, Toledo, OH.
STAR-DUST GEOMETRIES IN GALAXIES: THE EFFECT OF INTERSTELLAR MATTER DISTRIBUTIONS ON OPTICAL AND INFRARED PROPERTIES OF LATE-TYPE GALAXIES
J. M. Capuano, Jr., H. A. Thronson, Jr. (Wyoming Univ., Laramie.), and A. N. Witt *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 168-169 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

The presence of substantial amounts of interstellar dust in late-type galaxies affects observable parameters such as the optical surface brightness, the color, and the ratio of far-infrared to optical luminosity of these galaxies. We conducted radiative transfer calculations for late-type galaxy environments to examine two different scenarios: (1) the effects of increasing amounts of dust in two fixed geometries with different star distributions; and (2) the effects of an evolving dust-star geometry in which the total amount of dust is held constant, for three different star distributions. The calculations were done for ten photometric bands, ranging from the far-ultraviolet to the near-infrared (K), and scattered light was included in the galactic surface brightness at each wavelength. The energy absorbed throughout these ten photometric bands was assumed to re-emerge in the far-infrared as thermal dust emission. We also considered the evolutionary contraction of a constant amount of dust relative to pre-existing star distributions. Derived from text

N93-26789*# Space Telescope Science Inst., Baltimore, MD.
THE ENVIRONMENTS OF SEYFERT AND MARKARIAN GALAXIES
John W. MacKenty and Brian McLean *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 170-171 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

The environments of galaxies may affect both the presence and nature of the activity in their nuclei. We have undertaken a study of the environments of Seyfert and non-Seyfert Markarian galaxies to investigate the relationship between nuclear activity and external influences on the nucleus (MacKenty 1989; MacKenty, McLean, and Simpson 1990). Previous studies of the environments of Seyfert galaxies suggest a connection between the nature of the activity in the nuclear regions of the galaxy and its external environment. Petrosian (1982) finds Seyfert 2 galaxies to be located in regions of higher density than Seyfert 1 galaxies and Dahari (1984, 1985) finds an excess of close companions to Seyfert galaxies compared to field galaxies. In a study of 102 Markarian galaxies, MacKenty (1989) confirms these results yet finds that non-Seyfert Markarian galaxies have the same frequency of companion galaxies as Seyfert Markarian galaxies and concludes from their IRAS colors that the companion galaxies tend to enhance star formation rather than directly influence the nuclear activity. Derived from text

N93-26790*# New Mexico State Univ., Las Cruces. Dept. of Astronomy.
A RADIO CONTINUUM SURVEY OF EDGE-ON SPIRAL GALAXIES AT 90 cm
B. Heikkila, W. R. Webber, Jack O. Burns, R. A. M. Walterbos, and N. Duric (New Mexico Univ., Albuquerque.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 172-173 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Accurate spectral indices of the radio emission from both the thin disk and thick disk or halo components are critical to understanding the propagation mechanisms of electrons within spiral galaxies. The spectral indices give information of relative importance of diffusion and synchrotron energy loss in the propagation of electrons in the disk. Our goal of this survey is to locate a larger sample of spiral galaxies that exhibit halo phenomena so that a statistical analysis will be possible. Author

N93-26791*# Observatoire de Paris-Meudon (France).
CO DEFICIENCY IN GALAXIES OF THE FORNAX CLUSTER?
Cathy Horellou, Fabienne Casoli (Ecole Normale Superieure, Paris, France.), and Christophe Dupraz (Ecole Normale Superieure, Paris, France.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 174-175 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

There is ample observational evidence that cluster galaxies are different from those in the field. Interaction with the hot intracluster medium affects the morphology of the galaxies, their gaseous content and possibly their star-formation activity. Tidal encounters between galaxies also play an important role. The atomic component has been investigated in detail for several clusters, among them our neighbor Virgo. With the Swedish-ESO 15 m telescope, we have observed in the 12CO(1-0) transition the 23 brightest spirals and lenticulars of the Formax cluster. Derived from text

N93-26792*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
MOLECULAR GAS TEMPERATURE AND DENSITY IN SPIRAL GALAXIES
W. F. Wall, D. T. Jaffe (Texas Univ., Austin.), F. N. Bash (Texas Univ., Austin.), F. P. Israel (Leiden Univ., Netherlands.), P. R. Maloney (National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.), and F. Baas (Joint Astronomy Centre, Hilo, HI.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 176-177 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

We combine beam-matched CO-13, CO-12 J = 3 yields 2 and J = 2 yields 1 line data to infer the molecular gas excitation conditions in the central 500 to 1600 pc diameters of a small sample of infrared-bright external galaxies: NGC253, IC342, M 83, Maffei 2, and NGC6946. Additional observations of the J = 1 yields 0 lines of C-18O and CO-13 set limits on the opacity of the CO-13 J = 1 yields 0 line averaged over the central kiloparsec of these spiral galaxies. Author

N93-26793*# National Radio Astronomy Observatory, Socorro, NM.
THE DEPENDENCE ON MORPHOLOGY OF THE GAS CONTENT IN GALACTIC DISKS
D. E. Hogg and M. S. Roberts *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 178-180 Sponsored in part by NSF (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

The classification S0 was introduced by Hubble to serve as a description of galaxies whose morphological characteristics seemed to lie between the disk-dominated spirals and the spheroidal elliptical systems. Since then there has been extensive discussion as to whether this classification sequence is also an evolutionary sequence. Many studies have focussed on a particular feature such as the luminosity profile, the bulge-to-disk ratio, or the nature of the interstellar matter, but the question of the evolution remains contentious. Equally contentious is the question of the classification itself. For systems with well-developed disks there usually is no problem. Many spheroidal systems also are unambiguously classified as ellipticals in most catalogs. However, there are a number of early systems which have been reclassified following review using improved optical material. For example, Eder et al. (AJ, 102, 572, 1991) found that many of the S0 galaxies which are rich in neutral hydrogen have faint spiral features. The confusion about classification propagates into the discussion of the

properties of early-type systems. Attempts to put the classification system on a quantitative basis have in general been unsuccessful. Recently Sandage (private communication) has reviewed the classification of early systems and has defined a set of sub-classes for these objects. The S0 galaxies are divided into three groups, depending on the prominence of the disk. There are six subdivisions of Sa galaxies, depending upon the relative prominence of knots and other arm-like characteristics. We have explored the total gas content in these objects to see if there is a dependence on the galaxy morphology, as denoted by these new subclasses.

Derived from text

N93-26794*# Florida Univ., Gainesville. Dept. of Astronomy.

HI OBSERVATIONS OF DWARF GALAXIES OUT TO A DISTANCE OF 50 Mpc

Caroline Simpson and S. T. Gottesman *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 181-182 (For primary document see N93-26706 10-90)

Avail: CASI HC A01/MF A04

Here we report our preliminary findings from an HI search for dwarf galaxies in three environmentally distinct regions of the sky: a galactic void, a galactic cluster, and an interaction field. This study is sensitive at the 5(sigma) level to hydrogen masses as low as 5 x 10(exp 5) solar mass. We have made three possible detections of previously uncatalogued objects: one in the void field, and two in the cluster field. Reduction of the interaction field is in progress. Author

N93-26795*# Lafayette Coll., Easton, PA. Dept. of Physics.

GAS-RICH DWARF GALAXIES IN DENSE AND SPARSE ENVIRONMENTS

G. Lyle Hoffman *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 183-184 Sponsored in part by National Astronomy and Ionospheric Center (For primary document see N93-26706 10-90)

(Grants NSF AST-84-06392; NSF AST-87-13394; NSF AST-90-15181; NSF AST-84-15162; NSF AST-87-14475)

Avail: CASI HC A01/MF A04

Dwarf irregular galaxies (generically labelled Im for the present purposes) pose an enigma to students of galaxy evolution. In nearby groups and the Virgo cluster, Im galaxies are at least as abundant as spiral galaxies, and their low surface brightnesses and high gas-to-stars ratios suggest that (at least in the stochastic self-propagating star formation scenario) there should be significant numbers of HI clouds with masses approaching 10(exp 8) solar mass which have undergone very little or no star formation. To date, however, no clouds with so little star formation that they would not be recognized as Im galaxies on high-quality photographic plates have been identified. There have been suggestions that such dwarfs may be tidally disrupted in regions of high galactic density, but may be prevalent in low density regions. We offer data from three parallel programs relevant to this issue. (1) A large number of Im galaxies throughout the Local Supercluster have been mapped in the HI spectral line using the Arecibo Radiotelescope, and we can establish the frequency with which HI disks much more extended than their optically visible portions are found. (2) Our extensive mapping of spiral and dwarf galaxies in the Virgo cluster allows us to set stringent limits on the density of star-free Hi clouds in that cluster. (3) We have conducted a sampling of the void in the distribution of galaxies toward the super galactic pole, optimized for finding low-mass HI clouds at redshifts out to approximately 2000 km/s. Derived from text

N93-26796*# Max-Planck-Inst. fuer Extraterrestrische Physik, Garching (Germany).

THE 158 MICRON (CII) MAPPING OF GALAXIES: PROBING THE ATOMIC MEDIUM

S. C. Madden, N. Geis (California Univ., Berkeley.), R. Genzel, F. Herrmann, J. Jackson (Boston Univ., MA.), A. Poglitsch, G. J. Stacey (Cornell Univ., Ithaca, NY.), and C. H. Townes (California Univ., Berkeley.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 185-186 (For primary document see N93-26706 10-90)

Avail: CASI HC A01/MF A04

Using the MPE/UCB Far-infrared Imaging Fabry-Perot Interferometer (FIFI) on the Kuiper Airborne Observatory (KAO), we have made large scale maps of (CII) in the spiral galaxies NGC 6946, NGC 891, M83 and the peculiar elliptical Cen A, thus allowing for the first time, detailed studies of the spatial distribution of the FIR line emission in external galaxies. We find that the (CII) emission comes from a mixture of components of interstellar gas. The brightest emission is associated with the nuclear regions, a second component traces the spiral arms as seen in the nearly face on spiral galaxies NGC 6946 and M83 and the largest star forming/H2 regions contained within them, and another extended component of low brightness can be detected in all of the galaxies far from the nucleus, beyond the extent of CO emission. Author

N93-26797*# Max-Planck-Inst. fuer Extraterrestrische Physik, Garching (Germany).

FAR-INFRARED LINE IMAGES OF DWARF GALAXIES

A. Poglitsch, N. Geis (California Univ., Berkeley.), F. Herrmann, S. C. Madden, G. J. Stacey (Cornell Univ., Ithaca, NY.), C. H. Townes (California Univ., Berkeley.), and R. Genzel *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 187-188 (For primary document see N93-26706 10-90)

Avail: CASI HC A01/MF A04

Irregular dwarf galaxies are about ten times more widespread in the universe than regular spiral galaxies. They are characterized by a relatively low metallicity, i.e., lower abundance of the heavier elements (metals) with respect to hydrogen than in the solar neighborhood. These heavier elements in the form of molecules, atoms, or ions, which have radiative transitions in the infrared play a decisive role in the energy balance of the ISM and thereby for the formation of stars. Dwarf galaxies are thus model cases for the physical conditions in the early phase of the universe. Large Magellanic Cloud: 30 Doradus. The two nearest dwarf galaxies are the Magellanic clouds at a distance approximately 50 kpc. The LMC contains 30 Dor, a region with young, extremely massive stars which strongly interact with the surrounding ISM on account of their stellar winds and intense UV radiation. 30 Dor is the brightest object in the LMC at almost all wavelengths. Derived from text

N93-26798*# Wyoming Univ., Laramie. Infrared Observatory.

THE FATE OF CAPTURED GAS: NGC 3077 AND STAR FORMATION IN THE M81 SYSTEM

Harley A. Thronson, Jr. and John Carlstrom (Owens Valley Radio Observatory, Pasadena, CA.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 189-190 (For primary document see N93-26706 10-90)

Avail: CASI HC A01/MF A04

NGC 3077 is the third largest system in the M81 swarm of galaxies, after the giant spiral M81 itself and dwarf oddity M82. We are interested in exploring the fate of molecular material in NGC 3077. For that reason we have mapped the distribution of J = 1 to 0 CO emission in the central approximately 1 arcmin (1 kpc) diameter region of the galaxy using the Owens Valley millimeter-array with an angular resolution of 6.'7 x 5.'7 (110 pc x 90 pc). The results are shown on the following page as a series of velocity channel maps with delta v = 13 km s(exp -1).

Derived from text

N93-26799*# Astronomical Inst., Amsterdam (Netherlands).

DUST AND IONIZED GAS IN ELLIPTICAL GALAXIES: SIGNATURES OF MERGING COLLISIONS

Paul Goudfrooij and Teije deJong *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 191-192 Sponsored in part by Shell Nederland BV (For primary document see N93-26706 10-90)

Avail: CASI HC A01/MF A04

Traditionally elliptical galaxies were thought to be essentially devoid of interstellar matter. However, recent advances in instrumental sensitivity have caused a renaissance of interest in dust and gas in - or associated with - elliptical galaxies. In particular, the technique of co-adding IRAS survey scans has led to the detection of more than half of all ellipticals with BT less than 11 mag. in the Revised Shapley-Ames catalog, indicating the presence of 10(exp 7) - 10(exp 8) solar mass of cold interstellar matter (Jura et al. 1987). In addition, CCD multi-color surface photometry shows dust patches in about 30 percent of the cases studied to date (e.g., Veron-Cetty & Veron 1988). Thorough study of the gas and dust in ellipticals is important to (1) determine its origin (mass-loss from late-type stars, merging collisions with other galaxies or accretion inflows from cooling X-ray gas), and (2) investigate the 3-D shape of ellipticals, as can be

derived from the orientation of the dust lanes and the 2-D velocity field of the gas. An important result of our comprehensive CCD imaging program is that a relevant fraction (approximately 40 percent) of the sample objects exhibits dust patches within extended H-alpha+(NII) line-emitting filaments. This common occurrence can be easily accounted for if the dust and gas have an external origin, i.e., mergers or interactions with gas-rich galaxies. Evidence supporting this suggestion: (1) the ionized gas is usually dynamically decoupled from the stellar velocity field (see, e.g., Sharples et al. 1983, Bertola & Bettoni 1988); (2) it is shown in a companion paper (Goudfrooij et al. 1992) that internal stellar mass loss alone can not account for the dust content of elliptical galaxies. Derived from text

N93-26800*# Bonn Univ. (Germany). Radioastronomisches Inst.
THE MULTICOMPONENT STRUCTURE OF BULGES
Ralf-Juergen Dettmar, Thomas Krenz, and Andreas Barteldrees *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 193-194 Sponsored in part by DFG (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

The morphology of disk galaxies is usually described by two major components, the centrally concentrated spheroidal component, called the bulge, and an oblate disk. The ratio of there contribution to the total luminosity - the bulge-to-disk ratio - is one of the parameters characterizing the Hubble sequence. Following de Vaucouleurs (1948), for most galaxies the radial distribution of the outer spheroid is fairly well described by the r exp 1/4 law I(r)=I(sub 0) exp(-(alpha)r), whereas the radial luminosity distribution of the disk follows an exponential law: I(r)=I(sub 0) exp(-alpha(r exp 1/4)) (Freeman 1970), with r the radial distance from the center. I(sub 0) and alpha are characteristic constants for each individual galaxy. Parameters for the structural properties of these components give important constraints for models of the formation and evolution of galaxies. Therefore we have tried to decompose disk and bulge components from high S/N CCD observations of a sample of edge-on disk galaxies. A common procedure for the decomposition is to model one component in a region where it dominates and subtract it from the combined light distribution. This technique was successfully carried out e.g. by van der Kruit & Earl (1981, 1982) and Wakamatsu & Hamabe (1984, 1989). Here we present two more examples of bulge-dominated edge-on SO galaxies, namely ESO 506-G33 and NGC 7123, which show an additional small and concentrated central component besides disk and 'bulge'. Author

N93-26801*# Joint Astronomy Centre, Hilo, HI.
VELOCITY RESOLVED SPECTROSCOPY OF MOLECULAR HYDROGEN EMISSION IN NGC6240
G. S. Wright, T. R. Geballe, and J. R. Graham (California Univ., Berkeley.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 195-196 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

NGC6240 is a member of the class of luminous galaxies which emit a significant fraction of their total light in the infrared. Based on its highly disturbed morphology, Fosbury and Wall (1979) suggested that the system may be a merger of two gas rich galaxies. It has two nuclei separated by 2 arcsec which are visible in the near infrared and at radio wavelengths and CO observations show that the galaxy contains a large mass of molecular gas. Unusually strong H2 emission lines dominate the near infrared spectrum of this galaxy. The galaxy emits approximately 4x10(exp 7) solar luminosity in the 2.12 micron v = 1 to 0 S(1) line alone, an order of magnitude more than other merging or starburst galaxies. To provide a better understanding of the physical processes responsible for the H2 emission from NGC6240 we have begun a program to obtain high spectral resolution observations using the echelle in CGS4 on the UKIRT. Preliminary data which were obtained in February 1991 are presented here. It is intended to obtain further observations with twice the spatial and spectral resolution in June of this year. Derived from text

N93-26802*# Tokyo Univ. (Japan). Dept. of Astronomy.
OBSERVATIONS OF IRAS F10214+4724 AT THE NOBEYAMA MILLIMETER ARRAY
K. Sakamoto (Nobeyema Solar Radio Observatory, Japan.), S. Ishizuki (Nobeyema Solar Radio Observatory, Japan.), R. Kawabe (Nobeyema Solar Radio Observatory, Japan.), and M. Ishiguro (Nobeyema Solar Radio Observatory, Japan.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 197-198 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

F10214+4724 is an IRAS source at z=2.286 with L(sub FIR) approximately 10(exp 14) solar luminosity. The CO(3-2) emission was detected at the NRAO 12-m telescope, and its molecular gas mass was estimated to be (1-3)x10(exp 11) solar mass. This object is unique and important because it is the first high-z object from which molecular line emission is detected and it enables us to investigate molecular gas content, star forming material, at an early stage of galactic evolution. If IRAS F10214+4724 is a primeval galaxy at the formation process, it is possible the gas has not been collapsed yet to the galactic scale. On the other hand, it is also possible IRAS F10214+4724 is a merging or interacting system like the most of ultra-luminous infrared galaxies. However, since the first detection was made with a medium size single-dish telescope, the precise position, extent, and distribution of the molecular gas had not been determined. The aim of our aperture synthesis observations is therefore to determine position and distribution of molecular gas. Author

N93-26803*# Johns Hopkins Univ., Baltimore, MD. Dept. of Physics and Astronomy.
AGES, CHEMISTRY, AND TYPE 1A SUPERNOVAE: CLUES TO THE FORMATION OF THE GALACTIC STELLAR HALO
Tammy A. Smecker-Hane and Rosemary F. G. Wyse *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 199-200 Sponsored in part by AAUW and Zonta International (For primary document see N93-26706 10-90)
(Grant NSF AST-90-16226)
Avail: CASI HC A01/MF A04

We endeavor to resolve two conflicting constraints on the duration of the formation of the Galactic stellar halo - 2-3 Gyr age differences in halo stars, and the time scale inferred from the observed constant values of chemical element abundance ratios characteristic of enrichment by Type II supernovae - by investigating the time scale for the onset of Type Ia supernovae (SNIa) in the currently favored progenitor model - mergers of carbon and oxygen white dwarfs (CO WDs). Author

N93-26804*# Michigan Univ., Ann Arbor. Dept. of Astronomy.
HIGH VELOCITY CLOUDS IN NEARBY DISK GALAXIES
Eric Schulman, Joel N. Bregman, Morton S. Roberts (National Radio Astronomy Observatory, Socorro, NM.), and Elias Brinks (National Radio Astronomy Observatory, Socorro, NM.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 201-202 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Clouds of neutral hydrogen in our galaxy with the absolute value of v greater than 100 km/s cover approximately 10 percent of the sky to a limiting column density of 1 x 10(exp 18) cm(exp -2). These high velocity clouds (HVCs) may dominate the kinetic energy of neutral hydrogen in non-circular motion, and are an important though poorly understood component of galactic gas. It has been suggested that the HVCs can be reproduced by a combination of three phenomena: a galactic fountain driven by disk supernovae which would account for most of the HVCs, material tidally torn from the Magellanic Clouds, and an outer arm complex which is associated with the large scale structure of the warped galactic disk. We sought to detect HVCs in external galaxies in order to test the galactic fountain model. Author

N93-26805*# Wyoming Univ., Laramie.
A COMPARISON OF EXTINCTION CURVES FOR DUST IN GALAXIES OF DIFFERENT HUBBLE TYPES
Leisa K. Townsley and Jill S. Price (Bentley Coll., Boston, MA.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 203-204 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

A sample of 25 galaxies of various Hubble types has been observed in a variety of filters. Extinction curves have been generated for absorption regions in these galaxies using a technique which previously had been used on just a few galaxies; for example, NGC 205, NGC 185, NGC 3077, and M31. The results from these studies suggested that there may be

systematic trends in dust properties with Hubble type. This would not be surprising; dust properties should vary with metallicity, for example. It is well known that some galaxies and their interstellar materials should reflect this difference. Author

N93-26806*# Onsala Space Observatory (Sweden).
MOLECULAR CLOUDS IN THE CENTERS OF GALAXIES: CONSTRAINTS FROM HCN AND CO-13 LINE EMISSION
S. Aalto, J. H. Black (Arizona Univ., Tucson.), R. S. Booth, and L. E. B. Johansson *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 205-206 Sponsored in part by Swedish Natural Science Research Council; European Southern Observatory; Associated Universities, Inc.; and NSF (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

We have searched for HCN J=1-0 line emission in the centers of 12 galaxies and have detected it in 10 of them. We have obtained complementary data on J=1-0 and 2-1 transitions of CO-12 and CO-13 in these systems. The ratio of integrated intensities, I(CO 1-0)/I(HCN 1-0) = 25 +/- 11 for this sample. We find that HCN emission of this strength can be produced under conditions of subthermal excitation. In combination with the line ratios in CO and CO-13, HCN puts constraints on the mean conditions of molecular clouds and on the mix of cloud types within the projected beam. Author

N93-26807*# Max-Planck-Inst. fuer Radioastronomie, Bonn (Germany).
MOLECULAR GAS CONTENT OF GALAXIES IN THE HYDRA-CENTAURUS SUPERCLUSTER
W. K. Huchtmeier *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 207-208 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

A survey of bright spiral galaxies in the Hydra-Centaurus supercluster for the CO(1-0) transition at 115 GHz was performed with the 15m Swedish-ESO submillimeter telescope (SEST). A total of 30 galaxies have been detected in the CO(1-0) transition out of 47 observed, which is a detection rate over 60%. Global physical parameters of these galaxies derived from optical, CO, HI, and IR measurements compare very well with properties of galaxies in the Virgo cluster. Author

N93-26808*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
GALACTIC OSCILLATIONS
B. F. Smith and R. H. Miller (Chicago Univ., IL.) *In its* The Evolution of Galaxies and Their Environment Jan. 1993 p 209-210 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Several oscillations have been identified in spherical galaxy models. These are normal mode oscillations in a stable galaxy. Each has its own distinct period and spatial form, and each rings without detectable damping through a Hubble time. The most important are: (1) a simple radial pulsation (fundamental mode), in which all parts of the galaxy move inward or outward with the same phase; and (2) a second spherically symmetrical radial mode with one node, so material inside the node moves outward when material outside moves inward. Numerical experiments suggest that normal mode oscillations may be present in nearly all galaxies at a considerably higher amplitude than has previously been thought. Amplitudes typically run a few percent of equilibrium values, and periods are around 50-300 Myrs in typical galaxies. These time scales are long enough that gas trapped near the center could cool during an oscillation cycle, allowing star formation activity. The second mode oscillations could cause bursts of star formation. Author

N93-26809*# Princeton Univ. Observatory, NJ.
A NEW METHOD TO SIMULATE VERTICAL AND HORIZONTAL STRUCTURE IN GALACTIC DISKS
Julianne J. Dalcanton and James E. Gunn *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 211-212 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

We have modified the particles in an N-body treecode to have different softening lengths in the horizontal and vertical directions. This allows us to simultaneously have thin enough particles to resolve the vertical structure in galactic disks, and horizontally large enough particles to suppress the vertical heating due to two-body effects. Author

N93-26810*# North Carolina Univ., Chapel Hill.
THE VELOCITY FIELDS OF ELLIPTICAL GALAXIES: STEPS TOWARD A SOLUTION OF THE INTRINSIC SHAPE PROBLEM
Thomas S. Statler and Anne M. Fry *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 213-214 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

One of the few surviving signatures, at low redshift, of the process of galaxy formation should be the distribution of shapes of elliptical galaxies. Yet the problem of inferring this distribution from the observed ellipticals is still unsolved, because insufficient use has been made of kinematic information. The levels of 'sophistication' of the theoretical models and of the observations have up to now been poorly matched. The kinematic data available for most ellipticals consists of only major and minor axis spectra; and Franx et al. (1991) find, using simple geometric models, that the addition of only one kinematic parameter (the ratio of minor axis to major axis rotation velocity) to the photometry is just not enough to finely constrain the intrinsic shape distribution. On the other hand, the more elaborate self-consistent models (e.g., Levison and Richstone 1987, Statler 1987) have made only infrequent and model-dependent predictions of complicated velocity patterns, mostly at small radii, and have not discussed how they change with shape. Derived from text

N93-26811*# California Univ., Los Angeles.
IS A LOCAL BAR A GOOD PLACE TO FIND A COMPANION? THE NEAR INFRARED MORPHOLOGY OF MAFFEI 2
Robert L. Hurt, K. Michael Merrill (Kitt Peak National Observatory, Tucson, AZ.), Ian Gatley (Kitt Peak National Observatory, Tucson, AZ.), and Jean L. Turner *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 215-216 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Maffei 2 is one of the closest large spiral galaxies lying just beyond the Local Group. It would probably be one of the most heavily studied galaxies in the sky were it not for the approximately 5 magnitudes of visual extinction resulting from its position behind the Galactic plane. It is the site of a burst of nuclear star formation indicated by strong infrared and radii continuum emission. Interferometric maps of CO-12 and CO-13 emission indicate that star formation is associated with a barlike structure consisting of arms of molecular gas that extend from within approximately 50 pc of the dynamical center out to a radius of at least 500 pc. HI maps have shown the galaxy to have an angular extent of approximately 15 feet and a neutral gas mass typical of a large spiral galaxy. Derived from text

N93-26812*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
LUMINOSITIES OF H ALPHA EMITTING REGIONS IN A PAIR OF INTERACTING GALAXIES IN THE BOOTES VOID
D. Weistrop (Nevada Univ., Las Vegas.), P. Hintzen (Nevada Univ., Las Vegas.), R. Kennicutt (Arizona Univ., Tucson.), C. Liu (Arizona Univ., Tucson.), J. Lowenthal (Arizona Univ., Tucson.), K.-P. Cheng, R. Oliversen, and B. Woodgate *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 217-218 (For primary document see N93-26706 10-90)
(Contract NAS5-31231)
Avail: CASI HC A01/MF A04

Luminosities of H alpha emission from a pair of interacting galaxies in the low density environment of the Bootes void are presented. CG 692 (IRAS 1519+5050) has an H alpha luminosity of 2 x 10(exp 42) ergs s(exp -1), indicating a star formation rate of 18.4 solar mass yr(exp -1). Individual extranuclear H alpha regions have luminosities of approximately 10(exp 40) ergs s(exp -1). These luminosities are similar to those found for H II regions in bright, late-type galaxies in more densely populated parts of the Universe. Author

N93-26813*# New Mexico State Univ., Las Cruces. Dept. of Astronomy.
NUMERICAL SIMULATIONS OF BENT, DISRUPTED RADIO JETS

Chris Loken and Jack O. Burns *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 219-220 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

We present preliminary results from three-dimensional hydrodynamical simulations designed to investigate the physics of jet bending and disruption. The specific scenario considered here involves a mildly supersonic jet crossing a contact discontinuity at the interface between the interstellar medium (ISM) and the intercluster medium (ICM) and then encountering a cross-wind in the ICM. The resultant morphologies show many of the features observed in radio sources including jet flaring, bending, and extended tails. Author

N93-26814*# New Mexico State Univ., Las Cruces. Dept. of Astronomy.
NUMERICAL MODELS OF JET DISRUPTION IN CLUSTER COOLING FLOWS
Chris Loken, Jack O. Burns, Kurt Roettiger, and Mike Norman (Illinois Univ., Urbana.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 221-222 (For primary document see N93-26706 10-90)
(Grant NSF AST-90-12353)
Avail: CASI HC A01/MF A04

We present a coherent picture for the formation of the observed diverse radio morphological structures in dominant cluster galaxies based on the jet Mach number. Realistic, supersonic, steady-state cooling flow atmospheres are evolved numerically and then used as the ambient medium through which jets of various properties are propagated. Low Mach number jets effectively stagnate due to the ram pressure of the cooling flow atmosphere while medium Mach number jets become unstable and disrupt in the cooling flow to form amorphous structures. High Mach number jets manage to avoid disruption and are able to propagate through the cooling flow. Author

N93-26815*# Kapteyn Astronomical Lab., Groningen (Netherlands).
ATOMIC HYDROGEN IN THE DISTURBED EDGE-ON GALAXY NGC 4631
Richard J. Rand and J. M. vanderHulst *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 223-224 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

We present WSRT HI observations of the nearby, disturbed, edge-on galaxy NGC 4631. A low-resolution (45 in. x 87 in.) map shows previously unknown tidal debris at large distances from the plane, and two dwarf companions. A high resolution (12 in. x 22 in.) map reveals a very disturbed gas layer in NGC 4631, with a wealth of small-scale structure. The most striking discovery is a supershell in the eastern half of the disk with a diameter of about 3 kpc, a mass of approximately 10 exp 8 solar mass and a tentative expansion velocity of 45 km/s. If the expansion is real, the energy which must have been injected by supernovae to explain the shell's current parameters is roughly 4 x 10(exp 55) ergs. Such a high energy requirement suggests an alternative formation mechanism, such as a collision with a small companion. Author

N93-26816*# Illinois Univ., Urbana-Champaign. Dept. of Physics.
THE MORPHOLOGY OF AND LOCATIONS OF STAR FORMATION IN IMPACT INDUCED RING GALAXIES
Susan A. Lamb, Richard A. Gerber, and Dinshaw S. Balsara *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 225-226 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Observed ring galaxies appear to fall into two major types. The first tends to consist of isolated galaxies which display a smooth, apparently circular ring and a central nucleus. These have been variously classified as R(S) by de Vaucouleurs (1959) and as type O by Few and Madore (1986). The second class of ring galaxy nearly always has a close companion of comparable size (no less than about one tenth that of the ring galaxy). In these objects the ring is knotty in appearance, is usually elliptical, even when deprojected on the sky, and is often open on one side, having a 'horse shoe' or 'banana' shape. The nucleus does not usually appear at the center of the ring and is sometimes apparently absent, giving rise to an 'empty ring' galaxy. deVaucouleurs et al. (1976) designated this second type as RING, while Few and Madore (1986) have classified similar galaxies as P type. These galaxies have elevated far IR emission, bright HII regions, and blue spectral colors. The different environments of the two types or ring galaxy, together with their overall morphological and spectral differences suggest that the R(S)/O type are most probably the result of an instability that occurs in isolated galaxies, whereas the RING/P type appears to be the result of a recent collision between two roughly equal mass objects, at least one of which is a disk galaxy. Theys and Spiegel (1976) studied a sample of this latter type and identified three subclasses: RE: galaxies with crisp, empty rings; RN: galaxies like those of RE but with off-center nuclei; RK: galaxies having single dominant knots or condensations in the rings. A presentation of a preliminary understanding of the connections between these different observed forms in terms of parameters which are intrinsic to the galaxy system, such as time since collision and impact parameter, and in terms of our line of sight view is the purpose of this paper. Here we report results we have obtained from three dimensional computer simulations of collisions between equal mass galaxies, one of which is a rotating, disk galaxy containing both gas and stars and the other is an elliptical containing stars only. We have used a combined n-body/SPH program (see Balsara, 1990) to model fully self consistent models in which the halo mass is 2.5 times that of the disk and gas comprises ten percent of the disk mass. Derived from text

N93-26817*# National Radio Astronomy Observatory, Socorro, NM.
THE CRITICAL DENSITY FOR STAR FORMATION IN HII GALAXIES
Christopher L. Taylor (Minnesota Univ., Minneapolis.), Elias Brinks, and Evan D. Skillman (Minnesota Univ., Minneapolis.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 227-228 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

The star formation rate (SFR) in galaxies is believed to obey a power law relation with local gas density, first proposed by Schmidt (1959). Kennicutt (1989) has shown that there is a threshold density above which star formation occurs, and for densities at or near the threshold density, the DFR is highly non-linear, leading to bursts of star formation. Skillman (1987) empirically determined this threshold for dwarf galaxies to be approximately 1 x 10(exp 21) cm(exp -2), at a linear resolution of 500pc. During the course of our survey for HI companion clouds to HII galaxies, we obtained high resolution HI observations of five nearby HII galaxies. HII galaxies are low surface brightness, rich in HI, and contain one or a few high surface brightness knots whose optical spectra resemble those of HII regions. These knots are currently experiencing a burst of star formation. After Kennicutt (1989) we determine the critical density for star formation in the galaxies, and compare the predictions with radio and optical data. Author

N93-26818*# Alabama Univ., Huntsville. Dept. of Physics and Astronomy.
NUMERICAL SIMULATIONS OF GALACTIC WAKES
Eric A. Lufkin *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 229-230 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

We have performed a series of numerical simulations which examine the simple but realistic case of a galaxy with a smooth potential corresponding to a King profile, and with no interstellar medium. This corresponds to the case of an early-type cluster galaxy that has previously been stripped of its gas. The simulations provide a numerical basis for future work involving galaxies with interstellar media. We use a time-explicit finite difference code (Lufkin & Hawley 1992, ApJ submitted) to obtain solutions to the nonlinear equations for adiabatic flow in axisymmetry. The computational grid covers a region extending 500 kpc from a stationary galaxy radially and along the symmetry axis. We use a graded mesh, allowing for full resolution near the galaxy. Because the assumed potential has a finite depth, no artificial inner boundary condition is necessary; reflection symmetry at the axis is assumed. With a total grid size of 64 radial x 128 vertical, each run requires approximately 5 minutes of cpu time on the NCSA Cray-2. Derived from text

N93-26819*# Ecole Normale Superieure, Paris (France).
THE CASE OF MISSING CO-13 IN MERGERS
Fabienne Casoli (Observatoire de Paris-Meudon, France.), Christophe Dupraz

(Observatoire de Paris-Meudon, France.), and F. Combes (Observatoire de Paris-Meudon, France.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 231-232 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

We present a comparison of the CO-13 and CO-12 emissions of six systems of merging galaxies: NGC 828, NGC 3256, NGC 4194, NGC 6240, Arp 220, and Arp 299. The observations were made in both J=1-0 and J=2-1 transitions with the IRAM 30 m and SEST 15 m telescopes. In all galaxies but NGC 828, the CO-13 is much weaker than in spiral galaxies. The average emissivity ratios measured at the few kiloparsec scale are: CO-12(1-0)/CO-13(1-0) approx. equals 30, CO-12(2-1)/CO-13(2-1) approx. equals 40. These values are significantly larger than those usually measured in normal spiral galaxies, which are always between 5 and 15 for the J=1-0 line. We show that such a peculiar behavior cannot be interpreted as due to the dominant presence of diffuse gas and it cannot be attributed to optically thin CO emission either. The faint CO-13 emission of mergers must result from either an underabundance of CO-13 or an overabundance of CO-12. They may be accounted for by different mechanisms: CO-13 molecules are more easily photodissociated than CO-12 ones - however our observations seem to rule out physical conditions characteristic of photodissociation regions; in the course of the merging, large amounts of unprocessed gas, with a high (CO-12/CO-13) abundance ratio, are driven from the external regions of the progenitor galaxies to the new nucleus - this could increase the (CO-12/CO-13) ratio by a factor of 2; the interstellar medium can also be quickly enriched in C-12 (thus in CO-12) by a factor of 2, due to selective nucleosynthesis of this isotope (vs. C-13) in the massive stars born during the starburst. The last two processes can thus significantly contribute to the weakness of the CO-13 lines. The high CO-13-to-CO-12 line ratios that we have measured are due to the deep transformations that take place in the interstellar medium during the merging and the starburst: indeed, the only object with nearly normal line ratios, NGC 828, appears less perturbed and active in star formation than the other sources in the sample. In most mergers, the faintness of the CO-13 emission may indicate that the conversion factor from CO-12 emissivities to H2 column densities could differ substantially from the standard galactic value. Author (revised)

N93-26820*# Consejo Superior de Investigaciones Cientificas, Tenerife (Spain). Inst. de Astrofisca de Canarias.
DENSITY WAVE TRIGGERED STAR FORMATION IN GRAND DESIGN SPIRALS
J. Cepa, J. E. Beckman, and J. H. Knapen *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 233-234 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

In normal spiral galaxies the arms are the main sites for star formation. This is the cause of their optical contrast compared with the rest of the disc. The spiral structure can be observed as a higher concentration of H2 regions, neutral gas (both atomic and molecular via CO), dust and stars than in the interarm disc. It seens generally accepted that, at least in grand design spirals, there are density waves in the discs. However, several questions are not clear yet and still under discussion. An important question could be termed the triggering dilemma (by analogy with the 'winding dilemma' raised in the forties): Is the enhanced star formation in the spiral arms triggered by the passage of a system of density waves or is it simply due to the presence of a higher column density of gas there? In the present work, we use triggering in the same sense as the moderate to strong triggering defined by Elmegreen (1992), that is to say that star formation in the arms occurs at a rate faster than that in the interarm zone, relative to the available placental gas. Our group has designed several tests to elucidate whether or not star formation is triggered in the arms with respect to the interarm region and we summarize one of them, that of the ratio of the star formation efficiency in the arms divided by that of the interarm zone at the same galactocentric distance which we may call the relative massive star formation efficiency, where the efficiency is defined using the ratio of the mass of stars (evaluated via the H alpha flux) to the mass of neutral gas, atomic plus molecular (which must be measured with the adequate angular resolution). If the relative efficiency is of order unity, the star formation is proportional to the mass of gas, if some kind of induced star formation is present, the relative efficiency should be considerably larger than unity. Derived from text

N93-26821*# Minnesota Univ., Minneapolis.
TIDAL INTERACTIONS AND THE FORMATION OF MAGELLANIC SPIRAL GALAXIES
S. C. Odewahn, C. E. Woodward (Wyoming Univ., Laramie.), and J. M. Bailey (Agnes Scott Coll., Decatur, GA.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 235-237 (For primary document see N93-26706 10-90)
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The closest, brightest and best resolved galaxy in the sky, the Large Magellanic Cloud, is a prototype of the late-type disk systems referred to collectively as barred Magellanic spiral galaxies (SBm). These systems occupy a pivotal stage in the Hubble sequence since they represent the transition from spiral disk galaxies to chaotic, irregular galaxies and are characterized by an asymmetric spiral arm which emanates from one end of a high surface brightness bar. We present evidence that the formation of the one-armed spiral morphology involves the tidal interaction with a companion galaxy. In summary the major points of our observational investigation include the following: (1) The vast majority of one-armed spiral galaxies possess bright nearby neighbors which appear to be physically associated. (2) The HI gas distribution and kinematics of one pair of SBm galaxies clearly reveal this system to be tidally interacting. (3) The infrared properties of the bars in two SBm galaxies support optical studies of bar luminosity profiles in late-type systems, and also suggest that the formation of compact star forming regions in these bars may not be uncommon.
Derived from text

N93-26822*# Ohio State Univ., Columbus.
FORMATION OF MASSIVE CLOUDS AND DWARF GALAXIES DURING TIDAL ENCOUNTERS
Michele Kaufman, Bruce G. Elmegreen (International Business Machines Corp., Yorktown Heights, NY.), Magnus Thomasson (Nordisk Inst. for Teoretisk Atomfysik, Copenhagen, Denmark.), and Debra M. Elmegreen (Vassar Coll., Poughkeepsie, NY.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 238-239 (For primary document see N93-26706 10-90)
(Grant NSF AST-89-14969)
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Gerola et al. (1983) propose that isolated dwarf galaxies can form during galaxy interactions. As evidence of this process, Mirabel et al. (1991) find 10(exp 9) solar mass clouds and star formation complexes at the outer ends of the tidal arms in the Antennae and Superantennae galaxies. We describe observations of HI clouds with mass greater than 10(exp 8) solar mass in the interacting galaxy pair IC 2163/NGC 2207. This pair is important because we believe it represents an early stage in the formation of giant clouds during an encounter. We use a gravitational instability model to explain why the observed clouds are so massive and discuss a two-dimensional N-body simulation of an encounter that produces giant clouds. Derived from text

N93-26823*# Iowa State Univ. of Science and Technology, Ames. Dept. of Physics and Astronomy.
MODELS OF THE CARTWHEEL RING GALAXY: SPOKES AND STARBURSTS
Curtis Struck-Marcell *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 240-241 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Recent observations of this famous ring galaxy, including optical and near-infrared CCD surface photometry, and VLA radio continuum and 21 cm line mapping (Higdon 1992b, in prep.), have inspired a renewed modeling effort. Toomre's (1978, in The Large-scale Structure of the Universe, eds. Longair and Einasto) series of restricted three-body simulations demonstrated how the multiple rings could be produced in a nearly head-on galaxy collision. New models with a halo-dominated potential based on the 21 cm rotation curve are able to reproduce such details as the spacing between rings, ring widths, offset of the nucleus, and several kinematical features, thus providing strong support for the collisional theory. The new observations have shown there are little or no old stars in Cartwheel; it may consist

almost entirely of gas and stars produced as a result of compression in the ring wave. To model this process Smooth Particle Hydrodynamics (SPH) simulations of the Cartwheel disk have been performed. Fixed gravitational potentials were used to represent the Cartwheel and a roughly 30 percent mass collision partner. The interaction dynamics was treated as in the usual restricted three-body approximation, and the effects of local self-gravity between disk particles were calculated. We are particularly interested in testing the theory that enhanced star formation in waves is the result of gravitational instability in the compressed region (see e.g. Kennicutt 1989, ApJ 344, 685). The gas surface density in a number of simulations was initialized to a value slightly below the threshold for local gravitational instability throughout most of the disk. The first ring wave produces relatively modest compressions (a factor of order a few), triggering instability in a narrow range of wavelengths. Self-gravity in the disk is calculated over a comparable range of scales. Simulations were run with isothermal, adiabatic, and adiabatic with radiative cooling characterized by a relatively short timescale. The isothermal approximation is good except in the vicinity of the strong second (inner) ring, and several snapshots from one case are shown in the figure below. Flocculent spiral segments are present before the collision, and these are compressed into dense knots in the ring wave. These knots are likely to be sites of vigorous star formation. In the strong rarefaction behind the outer ring most of the knots are radially stretched and sheared, giving rise to spoke-like features. A few dense knots are evidently very tightly bound, because they retain their coherence and are stretched relatively little through the rarefaction. This is in accord with evidence for continuing star formation in some spokes (Marcum, Appleton and Higdon 1992). The number and spacing of spokes is a direct function of the scale of the gravitational instability in the disk. Thus, the gravitational instability theory, together with the hypothesis that massive stars are only formed in dense knots of gas, can account for most of the distinct morphology of the Cartwheel. Derived from text

N93-26824*# Indian Inst. of Science, Bangalore. Dept. of Physics.
CLUSTER TIDAL FIELDS: EFFECTS ON DISK GALAXIES
Monica Valluri *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 242-243 Sponsored in part by Council of Scientific and Industrial Research (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

A variety of observations of galaxies in clusters indicate that the gas in these galaxies is strongly affected by the cluster environment. We present results of a study of the dynamical effects of the mean cluster tidal field on a disk galaxy as it falls into a cluster for the first time on a bound orbit with constant angular momentum (Valluri 1992). The problem is studied in the restricted 3-body framework. The cluster is modelled by a modified Hubble potential and the disk galaxy is modelled as a flattened spheroid. Derived from text

N93-26825*# Minnesota Univ., Minneapolis.
HIGH CHEMICAL ABUNDANCES IN STRIPPED VIRGO SPIRAL GALAXIES
E. D. Skillman, R. C. Kennicutt (Arizona Univ., Tucson.), and G. A. Shields (Texas Univ., Austin.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 244-245 (For primary document see N93-26706 10-90)
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Based on a comparison of the oxygen abundances in H 2 regions in field and Virgo cluster late type spiral galaxies, Shields, Skillman, & Kennicutt (1991) suggested that the highly stripped spiral galaxies in the Virgo cluster have systematically higher abundances than comparable field galaxies. In April 1991 and May 1992 we used the blue channel spectrograph on the MMT to obtain new observations of 30 H 2 regions in Virgo spiral galaxies. These spectra cover the wavelength range from (O II) lambda 3727 to (S II) lambda 6731. We now have observed at least 4 H II regions in 9 spiral galaxies in the Virgo cluster. Combining (O II) and (O III) line strengths, we calculate the H II region oxygen abundances based on the empirical calibration of Edmunds & Pagel (1984). These observations show: (1) The stripped, low luminosity Virgo spirals (N4689, N4571) truly have abundances characteristic of much more luminous field spirals; (2) Virgo spirals which show no evidence of stripping (N4651, N4713) have abundances comparable to field galaxies; and (3) Evidence for transition galaxies (e.g., N4254, N4321), with marginally stripped disks and marginal abundance enhancements. The new observations presented here confirm the validity of the oxygen over-abundances in the stripped Virgo spirals. Shields et al. (1991) discussed two different mechanisms for producing the higher abundances in the disks of stripped galaxies in Virgo. The first is the supression of infall of near-primordial material, the second is the suppression of radial inflow of metal-poor gas. Distinguishing between the two cases will require more observations of the Virgo cluster spirals and a better understanding of which parameters determine the variation of abundance with radius in field spirals (cf., Garnett & Shields 1987). Author

N93-26826*# Tel-Aviv Univ. (Israel). School of Physics and Astronomy.
DEEP H ALPHA IMAGES OF INTERACTING GALAXIES
S. C. Beck and O. Kovo *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 246 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Gravitational interactions between galaxies are believed to increase star formation activity dramatically, and most of the brightest starburst galaxies show clear signs of recent interactions. However, it is still not known how interaction triggers star formation, nor are there models to relate the type or strength of interaction to the location or amount of star formation. We report on a series of deep H alpha images of interacting and post-interaction galaxies which we took with the purpose of finding the young stars and ionized gas in these objects. We were motivated in part by the hope that by studying the very recently formed stars we could see how the interaction process had affected the star formation. We observed the galaxies through 50 A-wide filters, one on the redshifted H alpha line and one off, and a standard R filter. Depending on the galaxy and conditions, images in the B, V, and I filters were also obtained. The images were recorded with a 4x7 ft. or 17 ft. diameter CCD at the 1-meter telescope of the Wise Observatory in Mitzpe Ramon. The H alpha and continuum images are used, together with observations at other wavelengths, to put together as complete a picture as possible of star formation and interactions in each galaxy. The complete observation set is not yet available for all the galaxies but certain results are already clear. There do not seem to be any correlations between H 1 and H alpha structures. In some H 1 plume galaxies H alpha extensions were seen on the other side of the galaxy from the H 1; in others extensive H alpha filaments have been found but not H 1. The preliminary results agree with the simplest model that interaction-induced star formation will be concentrated in the system center, since that is where the mass ends up. Derived from text

N93-26827*# Princeton Univ. Observatory, NJ.
DISSIPATIVE MERGING OF GALAXIES
M. Umemura (Tokyo Astronomical Observatory, Japan.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 247-248 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

The galaxy merging is investigated with hydrodynamical processes taken into account. For this purpose, the 3D calculations are performed by the use of a smoothed particle hydrodynamics (SPH) scheme combined with an N-body scheme. In these calculations, we find a new merging criterion and the dependence of the central phase space density of merger remnants upon the gas fraction in progenitors. It is concluded that ellipticals can be formed just by merging of fairly gas-rich primordial galaxies, not ordinary spiral galaxies. Author

N93-26828*# Space Telescope Science Inst., Baltimore, MD.
RADIO JETS IN COLLIDING GALAXIES: TESTING THE INTERACTION-ACTIVITY CONNECTION
Kirk D. Borne and Luis Colina (Universidad Autonoma de Madrid, Spain.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 249-250 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

The idea that galaxy interactions and merging are related to the generation of starburst and AGN activity in galactic nuclei has been the subject of intensive investigations over the past several years and is still a matter of lively debate. Peculiar morphologies, indicative of tidal interactions, have been detected in high-luminosity radio galaxies, in quasars, and in ultraluminous IRAS galaxies. In addition, low-luminosity radio and active galaxies show similar evidence for a recent merger or for nearby companions.

In a recent CCD optical study of galaxies selected on the basis that they all contain well defined radio jets, it was found that almost half of the sample consists of pairs of elliptical galaxies. Many of these low-luminosity radio galaxies with companions show a well defined distorted radio jet structure at the VLA scale with an S- or C-shaped morphology. We have developed a general numerical simulation algorithm for ballistic radio jets with the intention of applying this model to the study of the bent jets seen in colliding pairs of galaxies and with the hope of testing the well documented interaction-activity connection. In our model the morphological evolution of the jets is determined by their response to the simple mechanical forces (i.e., gravity and ram pressure) imposed on them from both the host and the companion galaxies. Radiative losses, jet precession, magnetic effects, relativistic terms, and hydrodynamic instabilities have all been ignored. Starting with a previously derived collision model for the interacting pair of elliptical galaxies NGC 4782/4783, we have used our algorithm to simulate the specific two-sided jet morphology seen in the radio source 3C 278, associated with NGC 4782. This is the first time that such jet simulations have been produced for a galaxy pair whose relative orbit was determined independently from the jet modeling. Derived from text

N93-26829*# Bonn Univ. (Germany). Radioastronomisches Inst.
DECLINING ROTATION CURVES IN INTERACTING GALAXIES
Ralf-Juergen Dettmar and Brian A. Skiff (Lowell Observatory, Flagstaff, AZ.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 251-252 Sponsored in part by DFG (For primary document see N93-26706 10-90)
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A declining rotation curve was recently found for the galaxy NGC 3521 by HI synthesis telescope observations (Casertano and van Gorkom 1991). From a comparison of the shapes of rotation curves for a larger sample of galaxies Casertano and van Gorkom argue that this is due to initial properties during the phase of galaxy formation. In several studies of global properties of galaxies, NGC 3521 was always considered a 'normal' unbarred, non-interacting, isolated spiral. However, we present CCD surface photometry that shows at low surface brightness levels the typical signs of interaction or even merging. Derived from text

N93-26830*# Harvard-Smithsonian Center for Astrophysics, Cambridge, MA.
A NEW OBSERVATIONAL AND NUMERICAL STUDY OF TIDAL INTERACTIONS IN M81-M82-NGC3077 SYSTEM
M. S. Yun, P. T. P. Ho, N. Brouillet (Bordeaux Univ., France.), and K. Y. Lo (Illinois Univ., Urbana.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 253-254 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

A nearby system of interacting galaxies M81-M82-NGC3077 triplet (D = 3.3 Mpc; Freeman & Madore 1988) has been studied using multi-wavelength observations and numerical simulations to obtain a comprehensive understanding on the dynamics and the consequences of tidal interactions in a group environment. The VLA 12-field Mosaic H I observations of 2 x 1.5 deg. region have revealed a vast array of H I filaments which suggests that the severity and extent of tidal disruptions far exceed the previous estimates. A tidal remnant of the former H I disk of M82 extending up to 30 kpc (in projection) is identified for the first time, and the pervasive effects of the tidal disruption are traced into the inner disk by optical and CO observations, including a kinematic trace of a large scale bar potential (Yun, Ho, & Lo 1992). The H I disk of M81 is traced out to 40 kpc in radius, and a large scale (I approx. 20 kpc) velocity anomaly ('High Velocity Trough'), which may be a remnant of a gaseous collision, is found within the disk of M81. The large H I bridge between M81 and NGC 3077 (van der Hulst 1979) is also found to extend approx. greater than 50 kpc further, bending around NGC 3077, toward M82. The total H I detected in this experiment, 5.6 x 10(exp 9) solar mass, represents the majority of the single-dish flux (Appleton, Davies, & Stephenson 1981) and suggests that the bulk of H I found in the region belongs to the three galaxies and the tidal filaments. The impact and details of the tidal interactions have been further examined through the use of numerical techniques. The 'restricted 3-body' approach was used to simulate the observed distribution of tidal H I streamers connecting the three galaxies, and the success of the simulation is further strengthened by the accurate predictions on the gas kinematics. Derived from text

N93-26831*# Universidad Autonoma de Puebla (Mexico). Facultad de Ciencias.
THE NATURE OF THE EVOLUTION OF GALAXIES BY MERGERS
Tapan K. Chatterjee *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 255-256 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

The merger theory for the formation of elliptical galaxies is examined by conducting a dynamical study of the expected frequency of merging galaxies on the basis of the collisional theory, using galaxy models without halos. The expected merger rates obtained on the basis of the collisional theory fall about a magnitude below the observational value in the present epoch. In the light of current observational evidence and the results obtained, a marked regularity in the formation of ellipticals is indicated, followed by secular evolution by mergers. Author

N93-26832*# Chicago Univ., IL. Dept. of Astronomy and Astrophysics.
MERGERS AT z = 1
Lancelot L. Kao *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 257-259 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Multiband images of nearby interacting pairs of galaxies, mergers, and normal field galaxies are used to simulate images of high redshift mergers by identifying distinctive morphological features. Preliminary results indicate that it is feasible for the HST to detect these high redshift objects. Author

N93-26833*# New Mexico State Univ., Las Cruces. Dept. of Astronomy.
A NUMERICAL SIMULATION OF GALAXY SUBCLUSTER MERGERS
Kurt Roettiger, Jack O. Burns, and Chris Loken *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 263-264 (For primary document see N93-26706 10-90)
(Grant NSF AST-90-12353)
Avail: CASI HC A01/MF A04

We present preliminary results of a 3-D numerical simulation of two merging subclusters of galaxies. By self-consistently modelling the intracluster gas and dark matter dynamics, we hope to gain insight as to how the dynamics of both relate to such observables as the cluster x-ray emission, radio source morphology, and velocity dispersions. Author (revised)

N93-26834*# Academy of Sciences, Potsdam (German D.R.).
LUMINOSITY SEGREGATION IN GALAXY CLUSTERS AS AN INDICATION OF DYNAMICAL EVOLUTION
F. W. Baier and K.-H. Schmidt *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 265-266 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Theoretical models describing the dynamical evolution of self-gravitating systems predict a spatial mass segregation for more evolved systems, with the more massive objects concentrated toward the center of the configuration. From the observational point of view, however, the existence of mass segregation in galaxy clusters seems to be a matter of controversy. A special problem in this connection is the formation of cD galaxies in the centers of galaxy clusters. The most promising scenarios of their formation are galaxy cannibalism (merger scenario) and growing by cooling flows. It seems to be plausible to consider the swallowing of smaller systems by a dominant galaxy as an important process in the evolution of a cD galaxy. The stage of the evolution of the dominant galaxy should be reflected by the surrounding galaxy population, especially by possible mass segregation effects. Assuming that mass segregation is tantamount to luminosity segregation we analyzed luminosity segregation in roughly 40 cD galaxy clusters. Obviously there are three different groups of clusters: (1) clusters with luminosity segregation, (2) clusters without luminosity segregation, and (3) such objects exhibiting a phenomenon which we call antisegregation in luminosity, i.e. a deficiency of bright galaxies in the central regions of clusters. This result is interpreted in the sense of different degrees of mass segregation and as an indication for different evolution stages of these clusters. The clusters are arranged in the three segregation classes 2, 1, and 0 (S2 = strong mass segregation, S1 = moderate mass segregation, S0 = weak or absent mass segregation). We assume that a

galaxy cluster starts its dynamical evolution after virialization without any radial mass segregation. Energy exchange during encounters of cluster members as well as merger processes between cluster galaxies lead to an increasing radial mass segregation in the cluster (S1). If a certain degree of segregation (S2) has been established, an essential number of slow-moving and relative massive cluster members in the center will be cannibalized by the initial brightest cluster galaxy. This process should lead to the growing of the predominate galaxy, which is accompanied by a diminution of the mass segregation (transition to S1 and S0, respectively) in the neighborhood of the central very massive galaxy. An increase of the areal density of brighter galaxies towards the outer cluster regions (antisegregation of luminosity), i.e. an extreme low degree of mass segregation was estimated for a substantial percentage of cD clusters. This result favors the cannibalism scenario for the formation of cD galaxies. Derived from text

N93-26835*# British Columbia Univ., Vancouver.
KINEMATICS OF COMPACT GROUPS AND MORPHOLOGIES OF THE MEMBER GALAXIES
Claudia MendesdeOliveira and Paul Hickson *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 267-268 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

We present the results of a kinematical and morphological study of galaxies in the Hickson compact groups. The redshift survey of 457 galaxies has been completed. The great majority of the galaxies have velocities within about 1000 km/s(exp -1) of the median velocity of the group. The velocities of the groups range from 1380 to 41731 km/s(exp -1) with a median of 8889 km/s(exp -1), corresponding to a median distance of 89 h(exp -1)Mpc. With the addition of the radial velocity selection criterion, a relatively large sample of physically dense compact groups was defined. The nature of the velocity dispersion-morphology relation (Hickson, Kindl and Huchra 1989, hereafter HKH) is investigated. This is the tendency of groups with high velocity dispersions to contain fewer late type galaxies. We find that this strong correlation is not due to any sample selection effects. The morphology concordance in compact groups (HKH), which is the trend for galaxies in a group to have similar morphological types, can be fully explained by the velocity dispersion-morphology correlation. A significant correlation is found between crossing time and the fraction of gas-rich galaxies in the groups. Groups with short crossing times typically contain fewer late-type galaxies. This may be evidence that significant dynamical evolution has occurred in these groups. Author (revised)

N93-26836*# New Mexico State Univ., Las Cruces. Dept. of Astronomy.
THE DYNAMICS OF ABELL 2634
J. Pinkney, George F. Rhee, Jack O. Burns, D. Batuski (Maine Univ., Orono.), J. M. Hill (Arizona Univ., Tucson.), P. Hintzen (Nevada Univ., Las Vegas.), and W. Oegerle (Space Telescope Science Inst., Baltimore, MD.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 269-270 (For primary document see N93-26706 10-90)
(Grant NSF AST-90-12353)
Avail: CASI HC A01/MF A04

We have amassed a large sample of velocity data for the cluster of galaxies Abell 2634 which contains the wide-angle tail (WAT) radio source 3C 465. Robust indicators of location and scale and their confidence intervals are used to determine if the cD galaxy, containing the WAT, has a significant peculiar motion. We find a cD peculiar radial velocity of 219 plus or minus 98 km s(exp -1). Further dynamical analyses, including substructure and normality tests, suggest that A 2634 is an unrelaxed cluster whose radio source structure may be bent by the turbulent gas of a recent cluster-subcluster merger. Author

N93-26837*# Kitt Peak National Observatory, Tucson, AZ.
X RAY OPACITY IN CLUSTER COOLING FLOWS
Michael W. Wise and Craig L. Sarazin *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 271-272 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

We have calculated the emergent x-ray properties for a set of spherically symmetric, steady-state cluster cooling flow models including the effects of radiative transfer. Opacity due to resonant x-ray lines, photoelectric absorption, and electron scattering have been included in these calculations, and homogeneous and inhomogeneous gas distributions were considered. The effects of photoionization opacity are small for both types of models. In contrast, resonant line optical depths can be quite high in both homogeneous and inhomogeneous models. The presence of turbulence in the gas can significantly lower the line opacity. We find that integrated x-ray spectra for the flow cooling now are only slightly affected by radiative transfer effects. However x-ray line surface brightness profiles can be dramatically affected by radiative transfer. Line profiles are also strongly affected by transfer effects. The combined effects of opacity and inflow cause many of the lines in optically thick models to be asymmetrical.
Author

N93-26838*# Michigan Univ., Ann Arbor. Dept. of Astronomy.
ON THE NATURE OF STAR FORMATION IN COOLING FLOW ELLIPTICALS
Patricia C. Hanlan, James M. Schombert (Jet Propulsion Lab., California Inst. of Tech., Pasadena.), and Mary Barsony (Harvard-Smithsonian Center for Astrophysics, Cambridge, MA.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 273-274 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

We present evidence based on narrow band optical and near-IR imaging that field and cluster cooling flow galaxies are enriched in low mass stars as a result of recent, truncated IMF star formation from accreting gas. We imaged 25 normal and 6 cooling flow ellipticals using a narrow blue band system. All galaxies have similar mean colors and color gradients. Near IR surface photometry was obtained for three normal ellipticals, three cooling flow ellipticals, and three cluster cooling flows. Derived from text

N93-26839*# Universidad Complutense, Madrid (Spain). Dept. de Astrofisica.
STAR FORMATION IN COOLING FLOW GALAXIES
Nicolas Cardiel and Javier Gorgas *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 275-276 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Spectroscopic observations of central dominant galaxies are reviewed. Through the analysis of absorption spectral features (mainly the strength of the Mg triplet at 5175 A and the break in 4000 A), both in the galaxy centers and along the radii, we will be able to impose limits on the ongoing star formation as the ultimate fate for the large amounts of accreted gas. With the same aim we will carry out a dynamical study based on velocity dispersion measurements. Author (revised)

N93-26840*# Kapteyn Astronomical Lab., Groningen (Netherlands).
JET INDUCED STAR FORMATION IN CENTRALLY DOMINANT GALAXIES?
Brian R. McNamara *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 277-278 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Using U-I CCD color maps of two centrally dominant cluster galaxies, we find unusual color structures which may be due to star formation which has been induced by their radio sources. These objects, located in the clusters A1795 and A2597, have blue central colors to radii of 20 kpc, spatially extended emission-line structures, and powerful radio sources. They reside at the centers of cooling flows with mass-accretion rates which are estimated to be approximately greater than 300 solar mass/yr. The regions of bluest local color are superposed on or along their radio-source structures. Our observations suggest that the radio sources associated with these objects may be inducing massive star formation in their central 20 kpc. The star formation may be the result of the radio plasma interacting with the warm emission-line gas and dense, x-ray emitting filaments similar to those recently discovered in two other clusters with the ROSAT Observatory. Since radio jets are likely to be transient, this may help to explain the scatter in the correlations between color and mass-accretion rate, although other factors may also contribute. Alternatively, scattered radiation from a hidden active nucleus or recent mergers may be responsible for the color structure. The color and radio properties of these objects are qualitatively similar but smaller in luminosity and spatial

extent to those found in high redshift radio galaxies. Our observations of galaxies at z approximately = 0.06-0.1 show that processes similar to 'the alignment effect' found in high redshift radio galaxies occur at more recent epochs. Author (revised)

N93-26841*# Colorado Univ., Boulder. Center for Astrophysics and Space Astronomy.

THE DETECTION OF LARGE AMOUNTS OF COOL, X RAY ABSORBING GAS IN DISTANT CLUSTERS OF GALAXIES. WHAT DOES THIS MEAN?

Qingde Wang (Joint Inst. for Lab. Astrophysics, Boulder, CO.) and John T. Stocke *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 279-280 (For primary document see N93-26706 10-90)

Avail: CASI HC A01/MF A04

We present an x-ray spectral study of 12 distant (z = 0.17-0.54) rich clusters of galaxies observed with the Einstein Observatory Imaging Proportional Counter. These x-ray spectral data show evidence for substantial excess absorptions beyond those expected in the galaxy, indicating the presence of large amounts of x-ray absorbing cool gas in these distant clusters. The mean value of the excess absorptions corresponds to an absorbing gas column density approximately greater than 10(exp 21)/sq cm. We calculate the x-ray luminosities of the clusters with observed fluxes only in the 0.8-3.5 keV band where the fluxes are less effected by the absorptions, and use the temperature-to-luminosity correlation (known only for nearby clusters) to estimate the temperatures of the hot intracluster medium (ICM) in the distant clusters. These temperature estimates, together with the spectral fits, provide further constraints on the column densities in the individual clusters. For the cluster CL 0016+16, the lower limit on the column density is found to be 8 x 10(exp 20)/sq cm at the 99 percent confidence limit. We also show that the ratio of the temperature obtained from the spectral fit to the temperature expected from the correlation tends to decrease with increasing look-back time, indicating possible temperature evolution of the hot ICM in the recent past. The inclusion of this evolutionary effect further increases the absorptions required in fitting the spectra. Derived from text

N93-26842*# Space Telescope Science Inst., Baltimore, MD.

MERGERS, COOLING FLOWS, AND EVAPORATION

W. B. Sparks *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 281-282 (For primary document see N93-26706 10-90)

Avail: CASI HC A01/MF A04

Mergers (the capture of cold gas, especially) can have a profound influence on the hot coronal gas of early-type galaxies and clusters, potentially inducing symptoms hitherto attributed to a cooling flow, if thermal conduction is operative in the coronal plasma. Heat can be conducted from the hot phase into the cold phase, simultaneously ionizing the cold gas to make optical filaments, while locally cooling the coronal gas to mimic a cooling-flow. If there is heat conduction, though, there is no standard cooling-flow since radiative losses are balanced by conduction and not mass deposition. Amongst the strongest observational support for the existence of cooling-flows is the presence of intermediate temperature gas with x-ray emission-line strengths in agreement with cooling-flow models. Here, x-ray line strengths are calculated for this alternative model, in which mergers are responsible for the observed optical and x-ray properties. Since gas around 10(exp 4) K is thermally stable, the cold cloud need not necessarily evaporate and hydrostatic solutions exist. Good agreement with the x-ray data is obtained. The relative strengths of intermediate temperature x-ray emission lines are in significantly better agreement with a simple conduction model than with published cooling-flow models. The good agreement of the conduction model with optical, infrared and x-ray data indicates that significantly more theoretical effort into this type of solution would be profitable. Author (revised)

N93-26843*# Columbia Univ., New York, NY.

A NEUTRAL HYDROGEN SURVEY OF THE HYDRA 1 CLUSTER

Pauline McMahon, Jacqueline vanGorkom, Otto Richter (Space Telescope Science Inst., Baltimore, MD.), and Henry Ferguson (Cambridge Univ., England.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 283-284 (For primary document see N93-26706 10-90)

Avail: CASI HC A01/MF A04

We are undertaking a project to image the entire volume of the Hydra 1 cluster of galaxies in neutral hydrogen using the VLA. This involves making a series of pointings spaced 30 min. (the half power beam width) apart, each observed at three velocity settings in order to span the whole velocity range of the cluster. The purpose of this survey is to determine the true distribution, both in space and velocity, of gas-rich systems and hence, to deduce what effects a dense environment may have on the evolution of these systems. Most surveys of clusters to date have been performed on optically selected samples. However, optically selected samples may provide misleading views of the distribution of gas-rich systems, since many low surface brightness galaxies have an abundance of neutral gas (Bothun et al. 1987, Giovanelli & Haynes 1989). The Hydra project is providing the first unbiased view of the HI distribution in a cluster of galaxies. Our 5 sigma sensitivity is 4.1 x 10(exp 7) solar M/beam, (assuming H(sub 0) = 75 km s(exp -1) Mpc(exp -1)) and our velocity resolution is 42 km s(exp -1). We have a spatial resolution of 45 sec., which means that only the largest galaxies are spatially resolved enough to determine HI disk size. Our coverage is about 50 percent of the central region plus eight other fields centered on bright spirals within about 2 deg. of the center. Author (revised)

N93-26844*# Harvard-Smithsonian Center for Astrophysics, Cambridge, MA.

USING X RAY IMAGES TO DETECT SUBSTRUCTURE IN A SAMPLE OF 40 ABELL CLUSTERS

J. J. Mohr, D. G. Fabricant, and M. J. Geller *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 285-286 (For primary document see N93-26706 10-90)

Avail: CASI HC A01/MF A04

Using a method for constraining the dynamical state of a galaxy cluster by examining the moments of its x-ray surface brightness distribution, we determine the statistics of cluster substructure for a sample of 40 Abell clusters. Using x-ray observations from the Einstein Observatory Imaging Proportional Counter (IPC), we measure the first moment M1(r), the ellipsoidal orientation angle theta2(r), and the axial ratio eta(r) at several different radii in the cluster. We determine the effects of systematics such as x-ray point source emission, telescope vignetting, Poisson noise, and characteristics of the IPC by measuring the same parameters on an ensemble of simulated cluster images. Due to the small band-pass of the IPC, the ICM emissivity is nearly independent of temperature so the intensity at each point in the IPC images is simply proportional to the emission measure calculated along the line of sight through the cluster (e.g. Fabricant et al. 1980). Therefore, barring a change superposition of two x-ray emitting clusters, a significant variation in the image centroid M1(r) as a function of radius indicates that the center of mass of the intra-cluster medium (ICM) varies with radius. We argue that such a configuration (essentially an m = 1 component in the ICM density distribution) is a non-equilibrium component; it results from an off-center subclump or a recent merger in the ICM. Derived from text

N93-26845*# New Mexico State Univ., Las Cruces. Dept. of Astronomy.

A STUDY OF THE X RAY ENVIRONMENT OF RADIO GALAXIES

George F. Rhee, Jack O. Burns, and Frazer Owen (National Radio Astronomy Observatory, Socorro, NM.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 287-288 (For primary document see N93-26706 10-90)

Avail: CASI HC A01/MF A04

We are currently working on a program to use extensive x-ray and radio databases to investigate the relationship between extended radio emission and environment in clusters of galaxies. The radio galaxy morphology is determined using VLA imaging and the x-ray properties are determined from Einstein IPC images. This study is motivated by the hypothesis that the key to understanding radio galaxies lies in the local environment. To test this hypothesis we have studied the detailed relationship between galaxy radio emission and the x-ray morphology of their parent clusters. In this pilot study we have used 35 radio sources found in 27 clusters. We have determined the position angle of the x-ray and radio emission, and x-ray and radio luminosities. The x-ray position was taken to be the position of peak flux of the subclump containing the radio galaxy.

The radio position was taken to be the position of the galaxy. We do not find a correlation between the x-ray and radio source position angle. This remains true when the sample is divided into subsamples according to radio morphology (wide angle tail, twin jet, narrow angle tail galaxies). We find a weak correlation between the radio source luminosity and the x-ray luminosity. We have computed the distance from the radio galaxy position to the center of the x-ray clump. We find a mean distance from the x-ray clump center of 0.16 Mpc for the radio galaxies in this sample. The mean distance to the nearest clump of x-ray emission is typically half the distance to the optical cluster center. We thus find strong evidence that radio galaxies are located very close to clumps of x-ray emission. These subclumps are not always affiliated with the central cluster x-ray emission. This supports our hypothesis that x-ray emission may provide a key to understanding radio galaxy morphology. We find evidence that radio galaxies occur in clusters that contain prominent substructures. Radio galaxies may thus provide an added diagnostic of the cluster dynamical state.

Derived from text

N93-26846*# Toronto Univ. (Ontario). Dept. of Astronomy.

MULTICOLOR PHOTOMETRY OF X RAY SELECTED ABELL CLUSTERS

Omar Lopez-Cruz (Instituto Nacional de Astrofisica, Opyica y Electronica, Tonantzintla, Mexico.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 289-290 Sponsored in part by National Council of Science and Technology and Natural Sciences and Engineering Research Council (For primary document see N93-26706 10-90)

Avail: CASI HC A01/MF A04

Strong evidence of evolution in cluster of galaxies at relatively low redshift has been indicated by recent x-ray studies. We are conducting a comprehensive optical study of a sample of Abell clusters that are strong x-ray emitters in order to test the x-ray evolution scenarios that have been proposed. The initial observations consist of three-color (B, R, I) imaging of low-redshift (0.025 less than z less than 0.25) Abell clusters using the T2KA CCD on the 0.9m telescope at KPNO the large field (23 ft. x 23 ft., approx. 1 Mpc at $z = 0.025$ and approx. 7 Mpc at $z = 0.25$) gives the unprecedented ability to sample most of the extent of the field of low-redshift clusters using a CCD. Given the advantages of CCDs over photographic plates, we expect to improve on many of the previous studies. A list of x-ray selected cluster of galaxies provides a homogeneous sample of true clusters that cannot be mistaken from apparent over-densities due to projection effects of field galaxies. Some optical indicators of cluster evolution are the population of ratios of cluster galaxies and their spatial distribution, a regular spiral-poor cluster is expected to be more evolved than an irregular spiral-rich cluster. Also regular spiral-poor clusters present high central concentrations while irregular spiral-rich are less concentrated. Variations in the Luminosity Function (LF) can indicate evolution. But in order to build reliable LFs it is necessary to determine the Hubble types of the cluster galaxies. In the past the classifications of cluster galaxies have been done by visual inspection on photographic material, this technique is very limited and can lead to errors when the galaxies are faint. The Hubble types of cluster galaxies can be determined in an objective manner by comparing colors and profiles from surface photometry. To show that this approach is feasible, I have presented preliminary results from the photometric analysis of the Abell-cluster A1213. Colors and profiles of the surface brightness distribution were compared to determine the Hubble types of the cluster galaxies. Author (revised)

N93-26847*# Arizona Univ., Tucson. Steward Observatory.

OPTICAL AND NEAR INFRARED PHOTOMETRY OF BUTCHER-OEMLER CLUSTERS

Lisa M. Shier and Marcia J. Rieke *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 291-292 (For primary document see N93-26706 10-90)

Avail: CASI HC A01/MF A04

Rich clusters of galaxies at moderate redshifts (z approx. .3) have a larger proportion of optically blue galaxies than their low redshift counterparts. Spectroscopic examination of the blue galaxies by various authors has shown that the blue galaxies are generally Seyferts, show evidence for recent star formation, or are foreground objects. Unfortunately, spectroscopy is too time consuming to be used on large samples. Thus, we have looked for a way to separate Seyferts, starbursts, ellipticals and nonmembers using photometry alone. Five moderate redshift clusters, Abell numbers 777, 963, 1758, 1961 and 2218, have been observed in the V, R and K bands. We model the spectral energy distributions of various kinds of galaxies found in clusters and derive observed colors. We have modeled the spectral energy distributions (SED) of several kinds of galaxies and compute their colors as a function of redshift. We expect to see ellipticals, spirals, starbursts, post-starburst and Seyfert galaxies. The SED of elliptical and Sbc galaxies was observed by Rieke and Rieke. The SEDs for the starburst galaxies was created by adding a reddened 10(exp 8) year old burst to a spiral galaxy SED. The post-starburst (E+A) galaxy SEDs are composed of a slightly reddened 10(exp 9) year old burst and elliptical galaxy SED. SEDs for the Seyferts were created by adding a v(exp -1.1) power law, and a hot dust thermal spectrum to the Sbc. From the SEDs the colors of galaxies at various redshifts with assorted filters were computed. Lilly & Gunn (1985) have optical and infrared photometry for a sample of galaxies in CL0024+1654 observed spectroscopically by Dressler, Gunn and Schneider (1985). We have used this data to choose the most appropriate SEDs for our starburst and post-starburst models. The most likely explanation for the optically blue colors in most cluster galaxies is star formation. Very few galaxies lie in the Seyfert locus. Abel 1758 has more Seyfert candidates than the other clusters, we observed. It seems possible to roughly sort types of galaxies in clusters by color alone. The cluster population seems to vary considerably between clusters, but our K selected sample has few Seyferts in any cluster. Author (revised)

N93-26848*# Kitt Peak National Observatory, Tucson, AZ.

DEEP, WIDE-FIELD, MULTI-BAND IMAGING OF z APPROXIMATELY EQUAL TO 0.4 CLUSTERS AND THEIR ENVIRONS

David R. Silva and Michael J. Pierce *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 293-294 (For primary document see N93-26706 10-90)

Avail: CASI HC A01/MF A04

The existence of an excess population of blue galaxies in the cores of distant, rich clusters of galaxies, commonly referred to as the 'Butcher-Oemler' effect is now well established. Spectroscopy of clusters at $z = 0.2$-0.4 has confirmed that the luminous blue populations comprise as much as 20 percent of these clusters. This fraction is much higher that the 2 percent blue fraction found for nearby rich clusters, such as Coma, indicating that rapid galaxy evolution has occurred on a relatively short time scale. Spectroscopy has also shown that the 'blue' galaxies can basically be divided into three classes: 'starburst' galaxies with large (O II) equivalent widths, 'post-starburst' E+A galaxies (i.e. galaxies with strong Balmer lines shortward of 4000A but elliptical-like colors, and normal spiral/irregulars. Unfortunately, it is difficult to obtain enough spectra of individual galaxies in these intermediate redshift clusters to say anything statistically meaningful. Thus, limited information is available about the relative numbers of these three classes of 'blue' galaxies and the associated E/SO population in these intermediate redshift clusters. More statistically meaningful results can be derived from deep imaging of these clusters. However, the best published data to date (e.g. MacLaren et al. 1988; Dressler & Gunn 1992) are limited to the cluster cores and do not sample the galaxy luminosity functions very deeply at the bluest wavelengths. Furthermore, only limited spectro-energy distribution data is available below 4000A in the observed cluster rest frame providing limited sensitivity to 'recent' star formation activity. To improve this situation, we are currently obtaining deep, wide-field UBRI images of all known rich clusters at z approx. equals 0.4. Our main objective is to obtain the necessary color information to distinguish between the E+SO, 'E+A', and spiral/irregular galaxy populations throughout the cluster/supercluster complex. At this redshift, UBRI correspond to rest-frame 2500A/UVR bandpasses. The rest-frame UVR system provides a powerful 'blue' galaxy discriminate given the expected color distribution. Moreover, since 'hot' stars peak near 2500A, that bandpass is a powerful probe of recent star formation activity in all classes of galaxies. In particular, it is sensitive to ellipticals with 'UV excess' populations (MacLaren et al. 1988). Author

N93-26849*# Universidad Complutense, Madrid (Spain). Dept. de Astrofisica.

SEARCHING FOR EMISSION-LINE GALAXIES: THE UCM SURVEY

J. Gallego, J. Zamorano, M. Rego, and A. Vitores *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 295-296 (For primary document see N93-26706 10-90)

Avail: CASI HC A01/MF A04

We are carrying out a long-term project with the main purposes of finding and analyzing low metallicity galaxies. A very small number of very low metallicity galaxies is known up to now. However these ojbects are particularly interesting since they are excellent candidates to 'young galaxies' in evolutionary sense as POX186 (Kunth, Maurogordato & Vigroux, 1988). Since the interstellar matter in these objects is only weakly contaminated by stellar evolution, their study could provide valuable information about the primordial helium abundance and therefore it could place constraints on the different Big-Bang models. The instrumental set up of our survey is an objective-prism used with the Schmidt telescope at Calar Alto Observatory. By using hypersensitized IIIaF emulsion and RG630 filter low resolution spectra in the H alpha region of objects in a wide field is obtained (Rego et al. 1989, Zamorano et al. 1990). Surveys carried out in the past two decades at optical blue wavelengths have also produced large samples of emission-line galaxies (ELGs), for example MacAlpine & Willians 1981 and reference therein, Wasilewski 1983, Salzer and MacAlpine 1988, or Smith et al. 1976. Relying primarily on objective-prism plates taken in the blue, these surveys have found over 3000 blue/emission-line galaxies so far. A significant number of star-forming galaxies are missed by optical surveys in the blue because of their low-excitation spectra (MacAlpine and Willians 1981, Markarian et al. 1981 and references therein) or their low metallicity (Kunth and Sargent, 1986). Derived from text

N93-26850*# British Columbia Univ., Vancouver.

MULTI-FILTER SPECTROPHOTOMETRY OF QUASAR ENVIRONMENTS

Sally E. Craven, Paul Hickson, and Howard K. C. Yee (Toronto Univ., Ontario.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 297-298 (For primary document see N93-26706 10-90)

Avail: CASI HC A01/MF A04

A many-filter photometric technique for determining redshifts and morphological types, by fitting spectral templates to spectral energy distributions, has good potential for application in surveys. Despite success in studies performed on simulated data, the results have not been fully reliable when applied to real, low signal-to-noise data. We are investigating techniques to improve the fitting process. Author (revised)

N93-26851*# Colorado Univ., Boulder. Center for Astrophysics and Space Astronomy.

THE ENVIRONMENT OF X RAY SELECTED BL LACS: HOST GALAXIES AND GALAXY CLUSTERING

Ron Wurtz, John T. Stocke, Erica Ellingson, and Howard K. C. Yee (Toronto Univ., Ontario.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 299-300 (For primary document see N93-26706 10-90)

Avail: CASI HC A01/MF A04

Using the Canada-France-Hawaii Telescope, we have imaged a complete, flux-limited sample of Einstein Medium Sensitivity Survey BL Lacertae objects in order to study the properties of BL Lac host galaxies and to use quantitative methods to determine the richness of their galaxy cluster environments. Author (revised)

N93-26852*# California Univ., Berkeley. Dept. of Astronomy.

NUCLEAR ACTIVITY AND THE ENVIRONMENTS OF NEARBY RADIO GALAXIES

Arjun Dey and Wil vanBreugel (Lawrence Livermore National Lab., CA.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 301-302 (For primary document see N93-26706 10-90)

Avail: CASI HC A01/MF A04

Much of our present understanding of galaxy evolution over a large redshift range is based on the study of samples selected on the basis of non-thermal radio emission. It is therefore necessary to understand the relationship between radio source activity and the host galaxy. Recent observations suggest that there is a connection between radio galaxy (RG) activity and radio galaxy evolution. For example, high-redshift RGs (z approx. greater than 0.7) show evidence for significant populations of young stars, and have optical continuum morphologies nearly always aligned with the radio axis (McCarthy et al. 1987; Chambers et al. 1987). This phenomenon is generally attributed to radio jet induced star formation (DeYoung 1989), but the lack of high S/N spectra of the galaxy continua, and recent detections of polarized light in a few objects make it hard to rule out other processes such as scattering or synchrotron radiation. A detailed study of the continuum light in the distant RGs is difficult as they are optically very faint. However, nearby RGs (z approx. less than 0.1) have bluer B-V colors than radio-quiet ellipticals, presumably due to the presence of young stellar populations (Smith and Heckman 1989) and several have extended UV continuum emitting regions along their radio axes (van Bruegel et al. 1985a, b, di Serego Alighieri et al. 1989), reminiscent of the alignment effect seen in the high redshift RGs. We have almost completed a continuum imaging survey of nearby (and therefore optically brighter), powerful RGs to study any possible relationships between the optical continuum light and radio source activity. In particular we are interested in (1) whether these lower redshift RGs shown any evidence of the alignment effect (in their rest-frame UV light) that is seen in the distant RGs, and (2) the effects that the radio source has on the environment of the host galaxy. Derived from text

N93-26853*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.

INFRARED CORONAL EMISSION LINES AND THE POSSIBILITY OF THEIR MASER EMISSION IN SEYFERT NUCLEI

Matthew A. Greenhouse (National Air and Space Museum, Washington, DC.), Uri Feldman (Naval Research Lab., Washington, DC.), Howard A. Smith (National Air and Space Museum, Washington, DC.), Marcel Klapisch (Artep, Inc., Washington, DC.), Anand K. Bhatia, and Abi Bar-Shalom (Israel Atomic Energy Commission, Beersheba.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 303-304 (For primary document see N93-26706 10-90)

Avail: CASI HC A01/MF A04

Energetic emitting regions have traditionally been studied via x-ray, UV and optical emission lines of highly ionized intermediate mass elements. Such lines are often referred to as 'coronal lines' since the ions, when produced by collisional ionization, reach maximum abundance at electron temperatures of approx. 10(exp 5) - 10(exp 6) K typical of the sun's upper atmosphere. However, optical and UV coronal lines are also observed in a wide variety of Galactic and extragalactic sources including the Galactic interstellar medium, nova shells, supernova remnants, galaxies and QSOs. Infrared coronal lines are providing a new window for observation of energetic emitting regions in heavily dust obscured sources such as infrared bright merging galaxies and Seyfert nuclei and new opportunities for model constraints on physical conditions in these sources. Unlike their UV and optical counterparts, infrared coronal lines can be primary coolants of collisionally ionized plasmas with 10(exp 4) less than T(sub e)(K) less than 10(exp 6) which produce little or no optical or shorter wavelength coronal line emission. In addition, they provide a means to probe heavily dust obscured emitting regions which are often inaccessible to optical or UV line studies. In this poster, we provide results from new model calculations to support upcoming Infrared Space Observatory (ISO) and current ground-based observing programs involving infrared coronal emission lines in AGN. We present a complete list of infrared (lambda greater than 1 micron) lines due to transitions within the ground configurations 2s(2)2p(k) and 3s(2)3p(k) (k = 1 to 5) or the first excited configurations 2s2p and 3s3p of highly ionized (x greater than or equal to 100 eV) astrophysically abundant (n(X)/n(H) greater than or equal to 10(exp -6)) elements. Included are approximately 74 lines in ions of O, Ne, Na, Mg, Al, Si, S, Ar, Ca, Fe, and Ni spanning a wavelength range of approximately 1 - 280 microns. We present new results from detailed balance calculations, new critical densities for collisional de-excitation, intrinsic photon rates, branching ratios, and excitation temperatures for the majority of the compiled transitions. The temperature and density parameter space for dominant cooling via infrared coronal lines is presented, and the relationship of infrared to optical coronal lines is discussed. Derived from text

N93-26854*# Rice Univ., Houston, TX.

INFLUENCE OF THE ACTIVE NUCLEUS ON THE MULTIPHASE INTERSTELLAR MEDIUM IN NGC 1068

Jonathan Bland-Hawthorn, Jon Weisheit, Gerald Cecil (North Carolina Univ., Chapel Hill.), and James Sokolowski (Space Telescope Science Inst., Baltimore, MD.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 305-306 (For primary document see N93-26706 10-90)

Avail: CASI HC A01/MF A04

The luminous spiral NGC 1068 has now been imaged from x-ray to

radio wavelengths at comparably high resolution (approximately less than 5 in. FWHM). The bolometric luminosity of this well-known Seyfert is shared almost equally between the active nucleus and an extended 'starburst' disk. In an ongoing study, we are investigating the relative importance of the nucleus and the disk in powering the wide range of energetic activity observed throughout the galaxy. Our detailed analysis brings together a wealth of data: ROSAT HRI observations, VLA lambda lambda 6-20 cu cm and OVRO interferometry, lambda lambda 0.4-10.8 micron imaging, and Fabry-Perot spectrophotometry. Derived from text

N93-26855*# Nevada Univ., Las Vegas. Dept. of Physics.
REDUCTION AND ANALYSIS OF VLA MAPS FOR 281 RADIO-LOUD QUASARS USING THE UNLV CRAY Y-MP SUPERCOMPUTER
Ailian Ding, Paul Hintzen, Donna Weistrop, and Frazer Owen (National Radio Astronomy Observatory, Socorro, NM.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 307-308 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

The identification of distorted radio-loud quasars provides a potentially very powerful tool for basic cosmological studies. If large morphological distortions are correlated with membership of the quasars in rich clusters of galaxies, optical observations can be used to identify rich clusters of galaxies at large redshifts. Hintzen, Ulvestad, and Owen (1983, HUO) undertook a VLA A array snapshot survey at 20 cm of 123 radio-loud quasars, and they found that among triple sources in their sample, 17 percent had radio axes which were bent more than 20 deg and 5 percent were bent more than 40 deg. Their subsequent optical observations showed that excess galaxy densities within 30 arcsec of 6 low-redshift distorted quasars were on average 3 times as great as those around undistorted quasars (Hintzen 1984). At least one of the distorted quasars observed, 3C275.1, apparently lies in the first-ranked galaxy at the center of a rich cluster of galaxies (Hintzen and Romanishin, 1986). Although their sample was small, these results indicated that observations of distorted quasars could be used to identify clusters of galaxies at large redshifts. The purpose of this project is to increase the available sample of distorted quasars to allow optical detection of a significant sample of quasar-associated clusters of galaxies at large redshifts. Derived from text

N93-26856*# Colorado Univ., Boulder. Center for Astro-Physics and Space Astronomy.
QUASARS IN RICH GALAXY CLUSTERS
Erica Ellingson and Howard K. C. Yee (Toronto Univ., Ontario.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 309-310 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

The evolution of AGN activity in rich clusters of galaxies is found to be approximately 5 times more rapid than that in poor clusters. This rapid evolution may be driven by evolution in the dynamics of galaxy cluster cores. Results from our spectroscopic studies of galaxies associated with quasars are consistent with this scenario, in that bright AGN are preferentially found in regions of lower velocity dispersion. Alternately, the evolution may be driven by formation of a dense intra-cluster medium (ICM). Galaxies close to quasars in rich cluster cores are much bluer (presumably gas rich) than galaxies in the cores of other rich clusters, in support of this model. Author (revised)

N93-26857*# Colorado Univ., Boulder. Center for Astro-Physics and Space Astronomy.
FINDING THE RAREST OBJECTS IN THE UNIVERSE: A NEW, EFFICIENT METHOD FOR DISCOVERING BL LACERTAE OBJECTS
John Stocke, Eric Perlman, Arno Granados, Jonathan Schachter (Harvard-Smithsonian Center for Astrophysics, Cambridge, MA.), Martin Elvis (Harvard-Smithsonian Center for Astrophysics, Cambridge, MA.), Meg Urry (Space Telescope Science Inst., Baltimore, MD.), Chris Impey (Arizona Univ., Tucson.), and Paul Smith (Arizona Univ., Tucson.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 311-312 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

We present a new, efficient method for discovering new BL Lac Objects based upon the results of the Einstein Extended Medium Sensitivity Survey (EMSS). We have found that all x-ray selected BL Lacs are radio emitters, and further, that in a 'color-color' diagram (radio/optical and optical/x-ray) the BL Lac Objects occupy an area distinct from both radio loud quasars and the radio quiet QSOs and Seyferts which dominate x-ray selected samples. After obtaining radio counterparts via VLA 'snapshot' observations of a large sample of unidentified x-ray sources, the list of candidates is reduced. These candidates then can be confirmed with optical spectroscopy and/or polarimetry. Since greater than 70 percent of these sources are expected to be BL Lacs, the optical observations are very efficient. We have tested this method using unidentified sources found in the Einstein Slew Survey. The 162 Slew Survey x-ray source positions were observed with the VLA in a mixed B/C configuration at 6 cm resulting in 60 detections within 1.5 position error circle radii. These x-ray/optical/radio sources were then plotted, and 40 BL Lac candidates were identified. To date, 10 candidates have been spectroscopically observed resulting in 10 new BL Lac objects! Radio flux, optical magnitude, and polarization statistics (obtained in white light with the Steward Observatory 2.3 m CCD polarimeter) for each are given. Author (revised)

N93-26858*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
IUEAGN: A DATABASE OF ULTRAVIOLET SPECTRA OF ACTIVE GALACTIC NUCLEI
G. Pike, R. Edelson, J. M. Shull (Colorado Univ., Boulder.), and J. Saken (Colorado Univ., Boulder.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 313-314 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

In 13 years of operation, IUE has gathered approximately 5000 spectra of almost 600 Active Galactic Nuclei (AGN). In order to undertake AGN studies which require large amounts of data, we are consistently reducing this entire archive and creating a homogeneous, easy-to-use database. First, the spectra are extracted using the Optimal extraction algorithm. Continuum fluxes are then measured across predefined bands, and line fluxes are measured with a multi-component fit. These results, along with source information such as redshifts and positions, are placed in the IUEAGN relational database. Analysis algorithms, statistical tests, and plotting packages run within the structure, and this flexible database can accommodate future data when they are released. This archival approach has already been used to survey line and continuum variability in six bright Seyfert 1s and rapid continuum variability in 14 blazars. Among the results that could only be obtained using a large archival study is evidence that blazars show a positive correlation between degree of variability and apparent luminosity, while Seyfert 1s show an anti-correlation. This suggests that beaming dominates the ultraviolet properties for blazars, while thermal emission from an accretion disk dominates for Seyfert 1s. Our future plans include a survey of line ratios in Seyfert 1s, to be fitted with photoionization models to test the models and determine the range of temperatures, densities and ionization parameters. We will also include data from IRAS, Einstein, EXOSAT, and ground-based telescopes to measure multi-wavelength correlations and broadband spectral energy distributions. Author (revised)

N93-26859*# Max-Planck-Inst. fuer Extraterrestrische Physik, Garching (Germany).
HIGH RESOLUTION 1-20 MICRON IMAGING OF THE NUCLEAR ENVIRONMENT OF NGC 1068
M. Cameron, J. W. V. Storey (New South Wales Univ., Sydney, Australia.), V. Rotaciuc, M. Blietz, R. Genzel, A. Krabbe, L. Verstraete, P. vanderWerf, S. Drapatz, and T. Lee (Royal Observatory, Edinburgh, Scotland.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 315-316 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

We present new mid-infrared continuum and near-IR line images of the nuclear environment of the nearby (14 Mpc) Seyfert 2 galaxy NGC 1068. The 8, 10, and 19 micron data were measured with our new mid-IR array camera, MIRACLE, at UKIRT in Nov. 1991 while our images of the H2 2.121 micron and (Fe 2) 1.64 micron lines were obtained with FAST, the MPE imaging spectrometer, at the 4.2m William Herschel Telescope in Aug. 1991. The MIRACLE data were imaged through narrow band (lambda/delta(lambda) greater than or equal to 50) filters whereas FAST incorporates a Fabry-Perot etalon (lambda/delta(lambda) greater than or equal to 950). Author (revised)

N93-26860*# Florence Univ. (Italy). Dipt. di Astronomia e Scienza.
NARROW BAND IMAGING AND LONG SLIT SPECTROSCOPY OF UGC 5101 Abstract Only
R. M. Stanga, F. Mannucci, and J. M. RodriguezEspinosa (Consejo Superior de Investigaciones Cientificas, La Laguna, Spain.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 317-318 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

UGC 5101 (z = 0.04; D is approximately equal to 240 Mpc) is one of the so called Ultraluminous IRAS sources. Two important properties of the members of this group are their L(sub IR) is greater than or equal to 10(exp 12) solar luminosity, and their space density in the universe up to z is less than 0.1 is equal or even larger than the space density of the quasars. Further noteworthy features of the Ultraluminous IRAS sources are their being morphologically peculiar and the fact that they all seem to host active nuclei in their center. We have observed UGC 5101 in an effort to study the interplay between the gas ionized by the central active nucleus and that gas ionized by other processes which may hold important clues to the understanding of the entire picture of this object. In particular these other ionizing processes could well be massive stars formed recently after the galactic encounter and shocks possibly also related to the galaxy collision. The data that we discuss were obtained between Dec. 1989 and Jan. 1992 with the WHT 4.2 m telescope using the two-arm spectrograph ISIS. Several spectral frames were obtained at three different position angles: PA 84--along the tail of the galaxy; PA 32--along the dust lane; and PA 110. The blue spectra are centered on the H beta line, while the red spectra are centered on the H alpha line. In the configuration we used for the long slit spectra, the spectral scale was 0.74 A per pixel, and the spatial scale was .37 arcsec per pixel; we also observed the H alpha region with a spectral scale of .37 A per pixel, at position angle 84. The narrow band images were obtained at the auxiliary port of ISIS, with a scale of .2 arcsec per pixel, and were centered at the H alpha wavelength, and on the adjacent continuum. The H alpha images and the spectra support the following model. UGC 5101 hosts an active nucleus; the NLR extends up to about 1.5 kpc and shows a complex velocity field, superimposed on the rotation curve of the galaxy. Besides the NLR, in the H alpha image are visible tow bright cones that extend up to 3 kpc along PA 32. The long slit spectra at PA 32 show that the velocity field of the gas in these regions is peculiar, while the ionization structure of the gas is similar to that of the NLR. Author (revised)

N93-26861*# Florence Univ. (Italy). Dipt. di Astronomia e Scienza.
LONG SLIT SPECTROSCOPY OF NGC 5506 Abstract Only
R. M. Stanga, R. Maiolino, and J. M. RodriguezEspinosa (Consejo Superior de Investigaciones Cientificas, La Laguna, Spain.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 319 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

The galaxy NGC 5506 hosts an active nucleus, that presents characteristics that are intermediate between Sy1 and Sy2. We discuss long slit spectra of NGC 5506 in the ranges 4675-5475 A and 6300-7125 A, that were obtained at three different position angles, in Apr. 1991 at the WHT 4.2 m telescope. The peculiar kinematics of the emitting gas has already been observed by other researchers; following the model proposed by the other researchers, that the emitting gas is located in two cones, we determined the aperture of the cones. The data, moreover, support the hypothesis that the gas is receding from the nucleus. We modelled the intensity and the ratios of the emission lines, and verified that the active nucleus of NGC 5506 can be described as a Sy1 nucleus, with the UV-X source that is partially obscured to our line of sight. On the contrary, a good fraction of the interstellar gas of the galaxy is directly illuminated and photoionized by the central source. Our data show evidence of star formation close to the nucleus; we estimated the star formation rate, that is high with respect to 'normal' spirals, but not high enough to be comparable to star formation rates in a starburst galaxy. Author

N93-26862*# National Central Univ., Chung-Li (Taiwan). Dept. of Physics.
STATIC GALACTIC HALO AND GALACTIC WIND
Chung-Ming Ko *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 320-321 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Although the exact state of the interstellar medium (ISM) in our Galaxy (other galaxies as well) is not clear at all, the 'common consensus' is that a rough pressure balance (or equipartition of energy) exists between different components and phases: cold, warm, hot phases of the ISM, magnetic field, cosmic rays, etc. If the halo of a galaxy is taken to be an extension of the ISM, then its structure is influenced by various ISM components. A 'complete' description of the halo is evidently very complicated. This paper gives a brief account on cosmic ray halo, which emphasizes the role played by cosmic rays. The interaction between cosmic rays and thermal plasma is facilitated by magnetic field. The cosmic rays are scattered by hydromagnetic waves (e.g., Alfven waves) which in turn can be generated by cosmic ray streaming instability. This constitutes a self-consistent picture. Since we are interested in the structure of the halo, we adopted a hydrodynamic model in which the cosmic rays and waves are described by their pressures. In general there are two classes of halos: static and dynamic. Author (revised)

N93-26863*# Colorado Univ., Boulder. Joint Inst. for Lab. Astrophysics.
TURBULENT MIXING LAYERS IN THE INTERSTELLAR MEDIUM OF GALAXIES
J. D. Slavin, J. M. Shull, and M. C. Begelman *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 322-323 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

We propose that turbulent mixing layers are common in the interstellar medium (ISM). Injection of kinetic energy into the ISM by supernovae and stellar winds, in combination with density and temperature inhomogeneities, results in shear flows. Such flows will become turbulent due to the high Reynolds number (low viscosity) of the ISM plasma. These turbulent boundary layers will be particularly interesting where the shear flow occurs at boundaries of hot (approximately 10(exp 6) K) and cold or warm (10(exp 2) - 10(exp 4) K) gas. Mixing will occur in such layers producing intermediate-temperature gas at T is approximately equal to 10(exp 5.0) - 10(exp 5.5) that radiates strongly in the optical, ultraviolet, and EUV. We have modeled these layers under the assumptions of rapid mixing down to the atomic level and steady flow. By including the effects of non-equilibrium ionization and self-photoionization of the gas as it cools after mixing, we predict the intensities of numerous optical, infrared, and ultraviolet emission lines, as well as absorption column densities of C 4, N 5, Si 4, and O 6. Author (revised)

N93-26864*# Space Telescope Science Inst., Baltimore, MD.
THE FORMATION OF LOW-IONIZATION EMISSION IN THE HALO OF NGC 891
James Sokolowski and Jonathan Bland-Hawthorn (Rice Univ., Houston, TX.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 324-325 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Imaging and Spectroscopic study first revealed the presence of a diffuse ionized medium (DIM), having unusual excitation, pervading the lower halo of the edge-on spiral galaxy NGC 891. Emission from this DIM is strongest northeast of the nucleus, at radii between 2 and 8 kpc (hereafter region 1). The (N2)(lambda)6583/H(alpha) and (S2)(lambda)(lambda)6716,6731/H(alpha) ratios increase dramatically with z in region 1, from 0.6 and 0.5 respectively at z is approximately equal to 500 pc to 1.1 and 1.0 at z is approximately equal to 1 kpc, while nondetections of (O1)(lambda)6300 and (O3)(lambda)5007 emission yield upper limits of (O1)(lambda)6300/H(alpha) less than or equal to 0.05 and (O3)(lambda)5007/H(alpha) less than or equal to 0.15 for z less than 1 kpc. Previous photoionization models, using the radiation field from disk O and B stars, have been successful in reproducing the elevated (N2)(lambda)6583/H(alpha) and (S2)(lambda)(lambda)6716.6731/H(alpha) ratios observed. However, these radiation bounded models also produce significant (O3)(lambda)5007 emission, in conflict with the observed upper limit. Here, we report the results of new, matter bounded models for the photoionization of the DIM in region 1 of NGC 891. Author (revised)

N93-26865*# New Mexico State Univ., Las Cruces.
THE DISK-HALO INTERFACE IN EDGE-ON SPIRALS

Rene Walterbos, Robert Braun (Netherlands Foundation for Radio Astronomy, Dwingelo.), and Colin Norman (Space Telescope Science Inst., Baltimore, MD.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 326-327 (For primary document see N93-26706 10-90)
(Contract NAS5-25555; NAG5-1924)
Avail: CASI HC A01/MF A04

We are studying the disk-halo interface in several edge-on spiral galaxies through extensive imagery in H(alpha) and other emission lines from Diffuse Ionized Gas (DIG), also referred to as the Warm Ionized Medium (WIM). In addition, for the nearby Sc galaxy NGC4631 we have obtained x-ray observations with ROSAT, to map the distribution of hot (10(exp 6) - 10(exp 7)) gas in the disk and halo. Here we present initial results for two late-type spirals, NGC4244 and NGC4631. Author (revised)

N93-26866*# Michigan Univ., Ann Arbor.
NUMERICAL MODELING OF THE INTERSTELLAR MEDIUM IN GALACTIC DISKS
A. Rosen, J. N. Bregman, and Michael L. Norman (Illinois Univ., Urbana.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 328-329 (For primary document see N93-26706 10-90)
(Grant NAGw-2135)
Avail: CASI HC A01/MF A04

We have been developing detailed hydrodynamic models of the global interstellar medium in the hope of understanding the mass and volume occupied by various phases, as well as their structure and kinematics. In our model, the gas is modeled by one fluid while representative Pop 1 stars are modeled by a second fluid. The two fluids are coupled in that the gas forms into stars at a rate given by a Schmidt law while stellar mass loss returns matter into the gas phase (on a time scale of 100 Myr). Also, the stars heat the gas through stellar winds and the gas cools through optically thin radiation. The time behavior of these two fluids is studied in two spatial dimensions with the Eulerian finite difference numerical hydrodynamic code Zen. The two spatial dimensions are along the plane of a disk (x, total length of 2 kpc) and perpendicular to the disk (z, total height of +/- 15 kpc) and a galactic gravitational field in the z direction, typical of that at the solar circle, is imposed upon the simulation; self-gravity and rotation are absent. For the boundary conditions, outflow is permitted at the top and bottom of the grid (z = +/- 15 kpc) while periodic boundary conditions are imposed upon left and right sides of the grid. As initial conditions, we assumed a gaseous distribution like that seen for the H1 by earlier researchers, although the results are insensitive to the initial conditions. We have run simulations in which the heating due to stars, parameterized as a stellar wind velocity, a, is varied from low (a = 150 km/s), to intermediate (a = 300 km/s), to high (a = 600 km/s). Since the intermediate case is roughly equivalent to the Galactic energy injection rate from supernovae, this summary will concentrate on results from this simulation. Author (revised)

N93-26867*# Hawaii Univ., Honolulu. Inst. for Astronomy.
THE VERTICAL DISK STRUCTURE OF THE EDGE-ON SPIRAL GALAXY NGC 3079
S. Veilleux, Jonathan Bland-Hawthorn (Rice Univ., Houston, TX.), G. Cecil (North Carolina Univ., Chapel Hill.), and R. B. Tully *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 330-331 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

NGC 3079 is an edge-on SB(s)c galaxy at a redshift of 1225 km/s relative to the Local Group. Earlier researchers found a spectacular 'figure-eight' radio structure aligned along the minor axis of the galaxy, centered on the nucleus, and extending 3 kpc above and below the plane. The geometry of this structure and the evidence of unusually high nuclear gas velocities suggest that a wind-type outflow from the nucleus is taking place. The disk of NGC 3079 is also remarkable: it is extremely rich in H 2 regions and is the only unambiguous example of a galaxy outside M31 and our own Galaxy to exhibit 'Heiles-like' shells. Other researchers have also identified a nebulosity with a ragged X-shaped morphology formed by a system of lumpy filaments with individual lengths of 3 - 5 kpc. They suggest that this material is ambient halo gas entrained into the boundary layers of the nuclear outflow. The complex structure of the line emission in NGC 3079 makes this object an ideal target for an imaging spectroscopic study. The present paper reports the preliminary results of such a study. Author (revised)

N93-26868*# Arizona Univ., Tucson. Dept. of Astronomy.
THE RING AROUND SN1987A
Crystal L. Martin and David Arnett *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 332-333 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Stars in the 9-40 solar mass range play a prominent role in the hydrodynamical and chemical evolution of galaxies. Their stellar winds and supernova explosions are believed to create the hot component of the interstellar medium (ISM). In some galactic disks, the kiloparsec sized super bubbles formed around clusters of massive stars may blow out of the disk plane and release hot, metal enriched gas into the galaxy's halo. Additionally, the expanding shock front of a super bubble in the disk may trigger additional star formation. Furthermore, similar processes probably drive the galactic winds associated with star burst nuclei that enrich the intracluster and intergalactic mediums. Nonetheless, the explosion of a blue super giant in the Large Magellanic Cloud (LMC), SN1987A, illuminated the incompleteness of our understanding of massive stars. Evolutionary models of massive stars do not synthesize the observed super giant populations in either the Milky Way or LMC. Our modeling of the formation of SN1987A's ring will improve our knowledge of both the post-main-sequence evolution of massive stars and their coupling to the ISM in galaxies. Author (revised)

N93-26869*# Harvard-Smithsonian Center for Astrophysics, Cambridge, MA.
A HALO AND A BLOW-OUT IN NGC 253
C. L. Carilli, M. A. Holdaway, and P. T. P. Ho (National Radio Astronomy Observatory, Socorro, NM.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 334-335 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

We present the discovery of a 'synchrotron halo' in NGC 253. NGC 253 is an inclined, dusty, barred Sc galaxy in the Sculptor Group. It is also one of the prototype nuclear star burst galaxies. Very Large Array observations at 327 MHz and 1.4 GHz have revealed a synchrotron emitting 'halo' extending 9 kpc above and below the plane of NGC 253 (assuming a distance of 4 Mpc). The spectral index for the radio emission steepens from -0.7 in the disk to -1.0 in the halo. The fractional polarization at 1.4 GHz increases from less than or equal to 2 percent in the disk up to 20 percent in the halo, and the magnetic field vectors project parallel to the plane over most of the halo. Author (revised)

N93-26870*# California Inst. of Tech., Pasadena.
INFRARED FINE-STRUCTURE LINE DIAGNOSTICS OF SHROUDED ACTIVE GALACTIC NUCLEI
G. M. Voit *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 336-337 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Far-infrared spectroscopy of celestial objects will improve dramatically in the coming decade, allowing astronomers to use fine-structure line emission to probe photoionized regions obscured in the optical band by thick clouds of dust. The ultraluminous far-IR galaxies revealed by IRAS, quasar-like in luminosity but smothered in molecular gas, probably conceal either immense starbursts or luminous active nuclei. In both scenarios, these objects ought to produce copious infrared fine-structure emission with several lines comparable to H(beta) in luminosity. This paper shows how these lines, if detected, can be used to determine the electron densities and far-IR obscurations of shrouded photoionized regions and to constrain the shape and ionization parameter of the ionizing spectra. The presence of (Ne V) emission in particular will distinguish shrouded AGN's from shrouded starbursts. Since all active galaxies photoionize at least some surrounding material, these diagnostics can also be applied to active galaxies in general and will aid in studying how an active nucleus interacts with the interstellar medium of its host galaxy. Author (revised)

N93-26871*# Texas Univ., Austin.
THE ABSORPTION AND EMISSION SPECTRUM OF RADIATIVE COOLING GALACTIC FOUNTAIN GAS
Robert A. Benjamin and Paul R. Shapiro *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 338 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

We have calculated the time-dependent, nonequilibrium thermal and ionization history of gas cooling radiatively from 10(exp 6) K in a one-dimensional, planar, steady-state flow model of the galactic fountain, including the effects of radiative transfer. Our previous optically thin calculations explored the effects of photoionization on such a flow and demonstrated that self-ionization was sufficient to cause the flow to match the observed galactic halo column densities of C 4, Si 4, and N 5 and UV emission from C 4 and O 3 in the constant density (isochoric) limit, which corresponded to cooling regions homogeneous on scales D less than or approximately equal to 1 kpc. Our new calculations which take full account of radiative transfer confirm the importance of self-ionization in enabling such a flow to match the data but allow a much larger range for cooling region sizes, i.e. D(sub 0) greater than or approximately equal to 15 pc. For an initial flow velocity v(sub 0) approximately equal to 100 km/s, comparable to the sound speed of a 10(exp 6) K gas, the initial density is found to be n(sub h,0) is approximately 2 x 10(exp -2) cm(exp -3), in reasonable agreement with other observation estimates, and D(sub 0) is approximately equal to 40 pc. We also compare predicted H(alpha) fluxes, UV line emission, and broadband x-ray fluxes with observed values. One dimensional numerical hydrodynamical calculations including the effects of radiative cooling are also presented. Author (revised)

N93-26872*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
REMOVING MALMQUIST BIAS FROM LINEAR REGRESSIONS c64
Frances Verter *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 339-340 (For primary document see N93-26706 10-90)
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Malmquist bias is present in all astronomical surveys where sources are observed above an apparent brightness threshold. Those sources which can be detected at progressively larger distances are progressively more limited to the intrinsically luminous portion of the true distribution. This bias does not distort any of the measurements, but distorts the sample composition. We have developed the first treatment to correct for Malmquist bias in linear regressions of astronomical data. A demonstration of the corrected linear regression that is computed in four steps is presented. Author (revised)

N93-26873*# California Univ., Berkeley.
A NEW GIANT LUMINOUS ARC GRAVITATIONAL LENS ASSOCIATED WITH A z = 0.62 GALAXY CLUSTER, AND THE ENVIRONMENTS OF DISTANT RADIO GALAXIES
Mark Dickinson *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 341 (For primary document see N93-26706 10-90)
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In the course of a survey investigating the cluster environments of distant 3CR radio galaxies, I have identified a previously unknown 'giant luminous arc' gravitational lens. The lensing cluster is associated with the radio galaxy 3C 220.1 at z = 0.62 and is the most distant cluster now known to produce such arcs. I present imaging and spectroscopic observations of the cluster and the arc, and discuss the implications for the cluster mass. At z greater than 0.6 the cluster velocity dispersions implied by such giant arcs may provide an interesting constraint on theories of large scale structure formation. The parent investigation in which this arc was identified concerns galaxy clusters and radio galaxy environments at 0.35 less than z less than 0.8. At the present epoch, powerful FR 2 radio galaxies tend to be found in environments of poor or average galaxy density. In contrast, at the higher redshifts investigated here, richer group and cluster environments are common. I present additional data on other clusters from this survey, and discuss its extension to z greater than 1 through a program of near-infrared and optical imaging. Author (revised)

N93-26874*# California Univ., San Diego, La Jolla.
EMISSION LINE GAS IN EARLY-TYPE GALAXIES: KINEMATICS AND PHYSICAL CONDITIONS
S. E. Deustua (Lawrence Livermore National Lab., CA.), A. P. Koratkar (Space Telescope Science Inst., Baltimore, MD.), and G. MacAlpine (Michigan Univ., Ann Arbor.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 342 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Recent studies have found line emission gas in nearby early-type galaxies, but the properties of the emission-line gas in these 'normal' galaxies remain enigmatic. In terms of activity in the nucleus, these LINER-like galaxies form an important link between giant H 2 region galaxies and low-luminosity Seyferts. Despite their large numbers and evolutionary significance, we do not know whether these galaxies form a homogeneous class of objects; nor do we know how the distribution and kinematics of the line emission gas are affected by the host galaxy's environment or by the properties of the central engine, if present. To address these issues we are conducting a magnitude and volume limited survey of nearby early-type galaxies at Lick Observatory and the Michigan-Dartmouth-MIT Observatory. We have selected approximately 100 galaxies from radio catalogs. A large sample is necessary because while studies of individual 'LINERS' have led to a certain understanding of the phenomenon, these studies have not provided a global framework. Here we present results from our first run of medium resolution (approximately 5 A FWHM) spectroscopy. Kinematic data and line ratios determined along the major and minor axes of 6 galaxies are discussed. The information gleaned from spectroscopic data, when combined with data at other wavelengths, will enable a thorough investigation into the nature of low luminosity nuclear activity. Author (revised)

N93-26875*# Space Telescope Science Inst., Baltimore, MD.
LOW REDSHIFT STAR-FORMING GALAXIES: WHAT CAN THEY TEACH US ABOUT PRIMEVAL GALAXIES?
D. Calzetti (European Space Agency, Paris, France.) and A. L. Kinney *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 343-344 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

The analysis of the UV plus optical spectra of three star-forming galaxies, Mrk 496, Mrk 357, TOL1924-416, obtained by matching the size of the optical aperture with that of IUE, has given unexpected results. These can be summarized as follows: (1) the dereddened Ly(alpha)/H(beta) ratios are consistent with the prediction of case B recombination for nebular emission, within the uncertainties; (2) the decrease of the Ly(alpha)/H(beta) ratio with increasing metallicities is not confirmed in our three objects, although the sample is too small to consider this result definitive. The first result is surprising, mainly because at least the two Markarian galaxies have a large enough H1 content to markedly increase the optical depth for the Ly(alpha) photons and to trigger their absorption by dust. This finding can probably be explained as an effect of the inhomogeneous distribution of gas and dust within the galaxies. On the basis of these results, we conclude that the detection of the Ly(alpha) emission line in searching for primeval galaxies (PG's) can be still considered a valid technique. Author (revised)

N93-26876*# Colorado Univ., Boulder. Center for Astrophysics and Space Astronomy.
COSMIC EVOLUTION OF EXTRAGALACTIC C 1, C 2, AND CO LUMINOSITY
John Bally, J. Michael Shull (National Inst. of Standards and Technology, Boulder, CO.), and Andrew J. S. Hamilton (National Inst. of Standards and Technology, Boulder, CO.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 345-346 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Carbon is the fourth most abundant element in the Galaxy with an abundance of approximately 4 x 10(exp -4) relative to hydrogen. Of all abundant metals it is the easiest to observe in the interstellar medium (ISM). Carbon can be found in four dominant forms: dust grains, C 2, C 1, and CO. The latter is the most abundant molecule (next to H2) in molecular clouds. All three gas-phase forms produce strong sub-mm wavelength emission lines and are the principal tracers of the warm and dense neutral

phases of the ISM. We calculate the gas-phase abundances of neutral carbon (C 1), ionized carbon (C 2), and carbon monoxide (CO) as a function of cosmic time or redshift z in an idealized scenario of galactic evolution. Author (revised)

N93-26877*# California Univ., Santa Cruz.
EMISSION LINE GALAXIES IN A NARROW STRIP TOWARD PERSEUS
Nancy E. Ellman *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 347-348 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Many studies have suggested that emission line galaxies (ELG's) have spatial distributions that differ from non-emission line galaxies. The ELG's tend to avoid rich clusters and may sometimes reside within voids. This paper describes work in progress on a redshift survey aimed both at determining the angular extent of the structures detected in deep pencil beam survey and at studying the characteristics of galaxies with respect to the rest of the sample. Author (revised)

N93-26878*# Space Telescope Science Inst., Baltimore, MD.
A SYSTEMATIC INVESTIGATION OF EDGE-ON STARBURST GALAXIES: EVIDENCE FOR SUPERNOVA-DRIVEN SUPERWINDS
Matthew D. Lehnert (Johns Hopkins Univ., Baltimore, MD.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 349 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

We are completing a project designed to realistically assess the global/cosmological significance of superwinds by attempting to systematize our understanding of them (determine their incidence rate and the dependence of their properties on the star-formation that drives them). Specifically, we are analyzing data from an optical spectroscopic and narrow-band imaging survey of an infrared flux-limited sample of about 50 starburst galaxies whose stellar disks are viewed nearly edge-on. This edge-on orientation is crucial because the relevant properties of the superwind can be far more easily measured when the flow is seen in isolation against the sky rather than projected onto the much brighter gas associated with the starburst galaxy itself. Author

N93-26879*# Texas Univ., Austin. Dept. of Astronomy.
AUTOMATA NETWORK MODELS OF GALAXY EVOLUTION
David Chappell and John Scalo *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 350-351 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Two ideas appear frequently in theories of star formation and galaxy evolution: (1) star formation is nonlocally excitatory, stimulating star formation in neighboring regions by propagation of a dense fragmenting shell or the compression of preexisting clouds; and (2) star formation is nonlocally inhibitory, making H2 regions and explosions which can create low-density and/or high temperature regions and increase the macroscopic velocity dispersion of the cloudy gas. Since it is not possible, given the present state of hydrodynamic modeling, to estimate whether one of these effects greatly dominates the other, it is of interest to investigate the predicted spatial pattern of star formation and its temporal behavior in simple models which incorporate both effects in a controlled manner. The present work presents preliminary results of such a study which is based on lattice galaxy models with various types of nonlocal inhibitory and excitatory couplings of the local SFR to the gas density, temperature, and velocity field meant to model a number of theoretical suggestions.
Author (revised)

N93-26880*# Observatoire de Marseille (France).
CAN CLUSTER ENVIRONMENT MODIFY THE DYNAMICAL EVOLUTION OF SPIRAL GALAXIES?
P. Amram, C. Balkowski (Observatoire de Paris-Meudon, France.), V. Cayatte (Observatoire de Paris-Meudon, France.), M. Marcelin, and W. T. Sullivan, III (Washington Univ., Seattle.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 355-356 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Over the past decade many effects of the cluster environment on member galaxies have been established. These effects are manifest in the amount and distribution of gas in cluster spirals, the luminosity and light distributions within galaxies, and the segregation of morphological types. All these effects could indicate a specific dynamical evolution for galaxies in clusters. Nevertheless, a more direct evidence, such as a different mass distribution for spiral galaxies in clusters and in the field, is not yet clearly established. Indeed, Rubin, Whitmore, and Ford (1988) and Whitmore, Forbes, and Rubin (1988) (referred to as RWF) presented evidence that inner cluster spirals have falling rotation curves, unlike those of outer cluster spirals or the great majority of field spirals. If falling rotation curves exist in centers of clusters, as argued by RWF, it would suggest that dark matter halos were absent from cluster spirals, either because the halos had become stripped by interactions with other galaxies or with an intracluster medium, or because the halos had never formed in the first place. Even if they didn't disagree with RWF, other researchers pointed out that the behaviour of the slope of the rotation curves of spiral galaxies (in Virgo) is not so clear. Amram, using a different sample of spiral galaxies in clusters, found only 10% of declining rotation curves (2 declining vs 17 flat or rising) in opposition to RWF who find about 40% of declining rotation curves in their sample (6 declining vs 10 flat or rising), we will hereafter briefly discuss the Amram data paper and compare it to the results of RWF. We have measured the rotation curves for a sample of 21 spiral galaxies in 5 nearby clusters. These rotation curves have been constructed from detailed two-dimensional maps of each galaxy's velocity field as traced by emission from the Ha line. This complete mapping, combined with the sensitivity of our CFHT 3.60 m. + Perot-Fabry + CCD observations, allows the construction of high-quality rotation curves. Details concerning the acquisition and reduction procedures of the data are given in Amram. We present and discuss our preliminary analysis and compare them with RWF's results. Author (revised)

N93-26881*# British Columbia Univ., Vancouver.
MULTI-FILTER SPECTROPHOTOMETRY SIMULATIONS
Kim A. S. Callaghan, Brad K. Gibson, and Paul Hickson *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 357-358 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

To complement both the multi-filter observations of quasar environments described in these proceedings, as well as the proposed UBC 2.7 m Liquid Mirror Telescope (LMT) redshift survey, we have initiated a program of simulated multi-filter spectrophotometry. The goal of this work, still very much in progress, is a better quantitative assessment of the multiband technique as a viable mechanism for obtaining useful redshift and morphological class information from large scale multi-filter surveys.
Author (revised)

N93-26882*# European Space Agency, Paris (France).
Ly ALPHA AND IR GALAXY COMPANIONS OF HIGH REDSHIFT DAMPED Ly ALPHA QSO ABSORBERS
Adeline Caulet and Mark McCaughrean (Arizona Univ., Tucson.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 359-360 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

We have used a Near-Infrared Camera and Multi-Object Spectrometer (NICMOS3) HgCdTe 256x256 array detector with the Infrared (IR) camera on the 2.3m telescope at Steward Observatory to image several Quasi-Stellar Object (QSO) fields. The limiting magnitude is K'(2.1 microns) = 21.0 - 21.5 mag per square arcsec for a 3 sigma detection in 3 hours of in-field chopping observations. Each QSO line-of-sight samples several known absorbers with Mg2(lambda)2796-2803 A and/or C4(lambda)1548-1551 A absorption doublets. The equivalent width distributions of the low and high ionization absorption lines of the absorber sample are identical to those of the parent population of all absorbers. This selection process, used already for a spectroscopic survey of Mg2 absorption lines in C4-selected absorption systems at high z, gives a methodical approach to observing, reduces the observer biases, and makes a more efficient use of telescope time. This selection guarantees that imaging of the sample of QSO fields will provide complete sampling of the whole population of high z QSO absorbers. Follow-up optical and IR spectroscopy of these objects is scheduled for redshift measurement and confirmation of the absorbing galaxies and the cluster members. Author (revised)

N93-26883*# Applied Research Corp., Port Washington, NY.
CENTRAL STAR FORMATION IN EARLY-TYPE GALAXIES: IMAGES AND IMPLICATIONS
L. L. Dressel and J. S. Gallagher, III (Wisconsin Univ., Madison.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 361-362 (For primary document see N93-26706 10-90)
(Grant NAG5-1630)
Avail: CASI HC A01/MF A04

We are reporting on an on-going study of strong central star-bursts in early type galaxies. These galaxies are brighter than m(pg) = 14.5 and are classified as type SO, SO/a, or Sa in the Uppsala General Catalog. All of them have unusually warm, bright far infrared sources for early-type galaxies, with F(100 microns)/F(60 microns) less than 2.0 and F(60 microns) greater than 2.5 Jy. Much of the infrared emission comes from the central few arcsec. Most of the galaxies were detected at 2380 MHz at Arecibo, with flux densities between 15 and 33 mJy. They have diffuse radio sources with a variety of morphologies, typically a few kpc in extent. Long slit spectra through the nucleus show that all have Balmer absorption lines, signifying a large B or A star population, and (O2) 3727 and Balmer emission lines, consistent with ionization by hot young stars. We have made optical continuum and emission line images of the galaxies to use in combination with the above data to study the causes and evolution of strong central star-bursts in early-type disk systems. Author (revised)

N93-26884*# Wales Univ. Inst. of Science and Technology, Cardiff. Dept. of Physics and Astronomy.
PROBING THE OPTICAL DEPTH OF SPIRAL GALAXIES USING MULTI-WAVEBAND OBSERVATIONS Thesis
Rhodri Evans *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 363-364 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

The questions of the optical depth and extinction of galaxies obviously have far-reaching implications; from determining the true stellar content and baryonic mass of galaxies to the origin of the major component of their far infrared radiation. We have investigated whether the reddening of stars can be used to determine the amount and extent of obscuring dust. We find that the amount of reddening is very sensitive to the assumed geometry. The usually assumed case of a screen of dust between the observer and the star produces, for a given optical depth, the maximum amount of reddening. However, for external galaxies such a geometry is clearly wrong. More realistic geometries where the dust and stars are uniformly mixed (a 'slab') or where the dust is sandwiched by unobscured stars (a 'sandwich') produce significantly less reddening. For the slab geometry of the reddening rises to a maximum value as the optical depth is increased, and for a sandwich geometry the reddening will actually decrease as the optical depth becomes larger. The reddening vectors produced by these realistic geometries are compared to multi-waveband observations of individual regions of a sample of eight galaxies. We find evidence for significant optical depths in the central regions of some of these galaxies, but optical depths of less than unity at approx. 2 scale lengths from the centers. The optical depths derived are in good agreement with other tests such as the measured hydrogen column densities and the far infrared to blue light ratios. However, whereas these two latter approaches are insensitive to the relative distributions of the stars and the dust, the amount of reddening seen in these eight galaxies suggests that the dust to stellar scale height ratio xi is greater than or equal to 0.5. We find typical blue band extinctions of A(sub B) = 0.75-1.0, a factor of 3-4 higher than the RC2 value. Author (revised)

N93-26885*# California Univ., Santa Cruz. Board of Studies in Astronomy and Astrophysics.
SPOKES IN RING GALAXIES
Lars Hernquist and Melinda L. Weil *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 365-366 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

We examine the response of self-gravitating primary galaxies consisting of dark matter halos and disks containing both stars and gas to collisions with less massive companions. The primaries were constructed using a technique which makes it possible to realize multi-component systems that are stable and virtually in precise equilibrium. A total of 65,536 particles were employed to represent the primary and 4096 to represent the companion. Half the particles in the primary comprise its halo and the other half its disk. Gas makes up 10 percent of the disk mass and is represented by 8192 of the disk particles. A system of units is used where the gravitational constant, total disk mass, and disk exponential scale length are unity. The primary motivation of the present study is to determine whether effects associated with dissipation and self-gravity can account for the unusual morphology of the Cartwheel galaxy.
Author (revised)

N93-26886*# Columbia Univ., New York, NY.
GAS IN MERGING GALAXIES
John E. Hibbard, Jacqueline H. vanGorkom, Steve Kasow, and David J. Westpfahl (New Mexico Inst. of Mining and Technology, Socorro.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 367-369 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

We present observations of the neutral hydrogen, ionized hydrogen, and starlight of galaxies chosen from the 'Toomre Sequence' of merging galaxies. This sequence is meant to represent the progressive stages of the merger of two disk galaxies into a single elliptical-like remnant. The galaxies in this study span the full range of this sequence. The stars and atomic gas are very differently distributed, with the stars more widely distributed at early stages, and the gas much more widely distributed at later stages. Large quantities of neutral gas are sent to large radii (greater than or approximately equal to 100 h(exp -1) kpc), and still persist even after the central remnant has relaxed to an r(sup 1/4) light profile. There are a few times 10(exp 9) solar masses h(exp -2) of both molecular and atomic gas in each of these systems. Throughout the different stages, about half of the total gas mass lies within the galaxies' optical bodies. The fraction of this mass that is in neutral hydrogen drops rapidly in the later stage mergers, suggesting that atomic gas is processed into molecular gas, stars, and hot gas during the merger and resulting starburst. Star formation occurs at all stages of the interaction, both within the tails and in the central bodies. In the early stages, the H(alpha) shows many arcs and plumes. In the late stages, there are large H 2 regions in the tails which are associated with large quantities of neutral hydrogen. There is always a very good correlation between optical, H(alpha), and H1 peaks, with N(sub H1) greater than or approximately equal 3 x 10(exp 20) cm(exp -2) at the location of the H2 regions in the tails. Author (revised)

N93-26887*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
THE ISM IN THE M82 STARBURST Abstract Only
Steven Lord *In its* The Evolution of Galaxies and Their Environment Jan. 1993 p 370-371 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

We have observed (O 1) (63 microns) and (Si 2) (35 microns) in the central 700 pc of the starburst galaxy M82. The luminosities in these transitions are 7.1 x 10(exp 7) solar luminosity and 6.2 x 10(exp 7) solar luminosity, respectively, which are each approx. 0.15% of the bolometric luminosity from this region. The ratios of (O 1) line luminosity to (O 3), (Si 2) (35 microns), and to bolometric luminosities in M82 are similar to those in M42, M17, and Sgr A. These similarities, and the association of the bulk of the (O 1) and (Si 2) emission with the ionized emission, suggest that the dominant emission mechanism for (O 1) and (Si 2) in M82 is the same as in these Galactic regions, namely warm gas photodissociated by UV flux from the OB stars responsible for the nearby H 2 regions. We argue that shock or x ray heated gas or H 2 plasma is a minor contributor to the intensities of these fine structure lines. Both the (O 1) (53 microns) and the (Si 2) (35 microns) spectrum show an asymmetric line profile indistinguishable in shape from those of the (O 3) (52 and 88 microns) and (N 3) (57 microns) lines and similar to that of the more extended (C 2) 158 micron line measured previously in M82. We detect two distinct velocity components, which we attribute to emission from two regions at either end of the central bar, where the bar connects to an orbiting torus of neutral gas seen in H 1 and CO J = 1-0. We model separately the two velocity components and derive the physical conditions in these two regions. The clouds in these regions are small, R approx. 1-2 pc, have warm neutral gas surfaces, T approx. 200 K, and are concentrated with

volume filling factors of approx. 0.02 and area filling factors of 1-5. The entire central region (R approx. 700 pc) is characterized by a large number, approx. 5 x 10(exp 4), of 2 x 10(exp 3) solar mass clouds with surface densities of approx. 3 x 10(exp 4) cm(exp -3), illuminated by FUV fluxes 10(exp 4) times the average local interstellar value for the Milky Way. These clouds reside in the harsh conditions of a starburst nucleus, with photoevaporation times of 10(exp 6) yr, and collision timescales only about an order of magnitude longer. Author (revised)

N93-26888*# Durham Univ. (England). Dept. of Physics.
DYNAMICS OF THE BARYONIC COMPONENT IN HIERARCHICAL CLUSTERING UNIVERSES
Julio Navarro *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 372-373 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

I present self-consistent 3-D simulations of the formation of virialized systems containing both gas and dark matter in a flat universe. A fully Lagrangian code based on the Smoothed Particle Hydrodynamics technique and a tree data structure has been used to evolve regions of comoving radius 2-3 Mpc. Tidal effects are included by coarse-sampling the density of the outer regions up to a radius approx. 20 Mpc. Initial conditions are set at high redshift (z greater than 7) using a standard Cold Dark Matter perturbation spectrum and a baryon mass fraction of 10 percent (omega(sub b) = 0.1). Simulations in which the gas evolves either adiabatically or radiates energy at a rate determined locally by its cooling function were performed. This allows us to investigate with the same set of simulations the importance of radiative losses in the formation of galaxies and the equilibrium structure of virialized systems where cooling is very inefficient. In the absence of radiative losses, the simulations can be rescaled to the density and radius typical of galaxy clusters. A summary of the main results is presented. Author (revised)

N93-26889*# Columbia Univ., New York, NY.
THE EFFECTS OF FLARING IN H1 ON THE OBSERVED VELOCITY FIELD OF SPIRALS
Rob Olling and J. H. vanGorkom *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 374-376 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

This work is part of a larger project in which we want to determine the shapes of dark halos around spiral galaxies. Rotation curves 'probe' the halos in the radial direction. The derived halo mass distributions are badly constrained. The local halo densities fully determine the width of the gas distribution once the gaseous velocity dispersion is known. There where the dark halo dominates, the Full Width at Half Maximum (FWHM) of the gas layer is proportional to (rho(sub halo))(exp -0.5). Therefore, measuring the width of the gas layer probes the halo density directly. In a dark halo dominated potential, the FWHM of the gas layer increases linearly with radius. This increase of the thickness of the gas layer is known as 'flaring'. Flaring has been found inside the stellar disk. Beyond the edge of the stellar disk, the analysis is hampered by the onset of the warp. Since the galaxy we are studying, NGC 4244, has no significant warp we hope to extend Rupen's analysis into the halo dominated regime. The usual method to derive a rotation curve from an observed 2-dimensional velocity field is to assume that the hydrogen is distributed in infinitely thin rings. For a flaring disk, any line of sight samples many different parts of the galaxy, all having different densities and projected velocities. In order to fully exploit the information contained in the gas distribution, we have to understand the effects of flaring on the observables (the spectrum for each point of the galaxy). We have investigated the effects of a flaring disk on the observed velocity field. It is obvious that the largest (kinematical) effects are to be expected for low density dark halos at large inclinations. For low mass galaxies we expect that the flaring of the H1 layer will have a major effect on the observed kinematics. For galaxy with intermediate V(sub max,halo) seen at intermediate inclinations, one overestimates Vsin(i) typically by a few percent. For more massive galaxies, any effects arising from the flaring H1 layer are minuscule unless the inclination is not too far from 90 deg. Author (revised)

N93-26890*# California Inst. of Tech., Pasadena.
THE LYMAN ALPHA FOREST OF THE HIGH-z QUASAR 0000-263
Bryan Penprase, Roberto Gilmozzi (Space Telescope Science Inst., Baltimore, MD.), David Bowen (Space Telescope Science Inst., Baltimore, MD.), and Piero Madau (Space Telescope Science Inst., Baltimore, MD.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 377-378 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Medium-resolution (delta(v) = 45 km/s) optical spectra of the bright, high-redshift (z = 4.1) quasar 0000-263 taken at the ESO 3.5-m NTT telescope were analyzed to determine the distribution of column densities, velocities and line widths of the Lyman-alpha forest absorption components. The values of NH, b, and z were determined by fitting Voigt profiles to the lines, and convolving with a Gaussian instrumental response function. Over 350 components with log N(sub H) greater than 13.2 were identified. An analysis of the dependence of the number of components with z reveals that the number evolution of components obeys the power law dN/dz varies as (1+z)(sup gamma), where gamma = 0.5 +/- 0.4 for the sample of 182 lines with log N(sub H) greater than 14.0. The distribution of component strengths is found to obey f(N(sub H)) varies as N(sub h)(sup -beta), where beta = -1.55 for components with log(N(sub H)) is greater than 14.7, and beta = -0.68 for the components with log(N(sub H)) greater than 13.5. A distinct break in the f(N(sub H)) histogram is also observed, at log(N(sub H)) is approximately 14.7. The results are briefly considered in the context of theoretical models of quasar Lyman alpha clouds and their evolution. Author (revised)

N93-26891*# Space Telescope Science Inst., Baltimore, MD.
H1 IN RSA GALAXIES
Otto-G. Richter *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 379-380 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

The original Revised Shapley-Ames (RSA) galaxy sample of almost 1300 galaxies has been augmented with further bright galaxies from the RSA appendix as well as newer galaxy catalogs. A complete and homogeneous, strictly magnitude-limited all-sky sample of 2345 galaxies brighter than 13.4 in apparent blue magnitude was formed. New 21 cm H1 line observations for more than 600 RSA galaxies have been combined with all previously available H1 data from the literature. This new extentise data act allows detailed tests of widely accepted 'standard' reduction and analysis techniques. Author (revised)

N93-26892*# Leiden Univ. (Netherlands).
EVOLUTION OF MOLECULAR CLOUDS
M. Sevenster *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 381-382 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

The evolution of interstellar molecular hydrogen was studied, with a special interest for the formation and evolution of molecular clouds and star formation within them, by a two-dimensional hydrodynamical simulation performed on a rectangular grid of physical sizes on the order of 100 pc. It is filled with an initial density of approx. 1 cm(exp -3), except for one cell (approx. 1 pc(exp 2)) at the center of the grid where an accretion core of 1-10(exp 3) solar masses is placed. The grid is co-moving with the gridcenter that is on a circular orbit around the Galactic center and that also is the guiding center of epicyclic approximation of orbits of the matter surrounding it. The initial radial velocity is zero; to account for differential rotation the initial tangential velocity (i.e. the movement around the galactic center) is proportional to the radial distance to the grid center. The rate is comparable to the rotation rate at the Local Standard of Rest. The influence of galactic rotation is noticed by spiral or elliptical forms, but on much longer time scales than self gravitation and cooling processes. Density and temperature are kept constant at the boundaries and no inflow is allowed along the tangential boundaries. Author (revised)

N93-26893*# Wisconsin Univ., Madison.
POWERING THE SUPERWIND IN NGC 253
Alan Watson, Jay Gallagher, Michael Merrill (Kitt Peak National Observatory, Tucson, AZ.), Jean Keppel (Keppel, Jean, Prescott, AZ.), and Mark Phillips (Cerro Tololo Inter-American Observatory, La Serena, Chile.) *In* NASA.

Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 383-385 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

NGC 253 is a prototypical moderate nuclear starburst galaxy. It is a barred SBc spiral galaxy at a distance of approximately 3 Mpc and can be studied on scales down to 15 pc in the optical and near IR. It is a bright IRAS source with a flux of 1000 Jy at 60 microns and a FIR luminosity of 3 x 10(exp 10) solar luminosity. It has a strong Br(gamma) emission line, a signature of ongoing massive star formation and deep CO absorption bands, which are indicative of the dominance of red supergiants in the near IR. It contains a population of compact radio sources, similar to those seen in M82. Optical spectra show that the nucleus is heavily reddened, with a Balmer decrement of approximately 30. NGC 253 possesses a 'superwind,' seen both in x-ray emission and in optical line emission. Nuclear ejection was first suggested to explain the kinematics of the nuclear region. We have obtained J, H, and K images of the entire galaxy at 1.3 arcsec/pixel (18 pc/pixel) using the superconducting quantum interference device (SQUID) on the KPNO 1.3 m. We have constructed a mosaic of 180 s exposures which traces the galaxy over much of its optical extent. The data were shifted, rotated, magnified, and calibrated following normal practice. Author (revised)

N93-26894*# European Southern Observatory, La Silla (Chile).
CO-12 J = 2-1 MAP OF THE DISK OF CENTAURUS A: EVIDENCE FOR LARGE SCALE HEATING IN THE DUST LANE
W. Wild, M. Cameron (Max-Planck-Inst. fuer Extraterrestrische Physik, Garching, Germany.), A. Eckart (Max-Planck-Inst. fuer Extraterrestrische Physik, Garching, Germany.), R. Genzel (Max-Planck-Inst. fuer Extraterrestrische Physik, Garching, Germany.), H. Rothermel (Max-Planck-Inst. fuer Extraterrestrische Physik, Garching, Germany.), G. Rydbeck (Onsala Space Observatory, Sweden.), and T. Wiklind (Onsala Space Observatory, Sweden.) *In* NASA. Ames Research Center, The Evolution of Galaxies and Their Environment Jan. 1993 p 386-387 (For primary document see N93-26706 10-90)
Avail: CASI HC A01/MF A04

Centaurus A (NGC 5128) is a nearby (3 Mpc) elliptical galaxy with a prominent dust lane, extensive radio lobes, and a compact radio continuum source, suggestive of nuclear activity. As a consequence of its peculiar morphology, this merger candidate has been the subject of much attention, particularly at optical wavelengths. Unfortunately the high and patchy extinction in the disk, aggravated by the warped structure of the dust lane, has severely hindered investigations into the properties of the interstellar medium, particularly with regard to the extent of star formation. Here we present a map of the C-12(O) J = 2-1 line throughout the dust lane which, when combined with a previously measured C-12(O) J = 1-0 map and data on molecular absorption lines observed against the compact non-thermal continuum source, offers insight into the excitation conditions of the molecular gas. Author (revised)

N93-27287*# Rensselaer Polytechnic Inst., Troy, NY. Dept. of Physics.
THE ORIGIN AND EVOLUTION OF DUST IN INTERSTELLAR AND CIRCUMSTELLAR ENVIRONMENTS Status Report, 1 Jul. 1992 - 30 Apr. 1993
Douglas C. B. Whittet and Chun M. Leung Apr. 1993 58 p
(Grant NAGw-3144)
(NASA-CR-193025; NAS 1.26:193025) Avail: CASI HC A04/MF A01

This status report covers the period from the commencement of the research program on 1 Jul. 1992 through 30 Apr. 1993. Progress is reported for research in the following areas: (1) grain formation in circumstellar envelopes; (2) photochemistry in circumstellar envelopes; (3) modeling ice features in circumstellar envelopes; (4) episodic dust formation in circumstellar envelopes; (5) grain evolution in the diffuse interstellar medium; and (6) grain evolution in dense molecular clouds. Derived from text

N93-27537*# Smithsonian Astrophysical Observatory, Cambridge, MA.
MOLECULAR PROCESSES IN COMETS Final Report, 1 Jan. 1978 - 31 Dec. 1988
A. Dalgarno Apr. 1993 23 p
(Grant NsG-7421)
(NASA-CR-193143; NAS 1.26:193143) Avail: CASI HC A03/MF A01

A major effort was expended in developing procedures for calculating by quantum-mechanical methods the cross sections for the photodissociation of the hydroxyl radical OH. The molecule OH is the primary dissociation product of water and observations of OH when combined with a determination of the lifetime of OH in the solar radiation field can be used to calculate the rate of release of water from comets. There are many possible photodissociation channels whose efficiency depends upon the details of the spectrum of the radiation. We have calculated the potential energy curves of all the states of OH that can be reached by electric dipole absorption from the ground X(exp 2)(Pi) state by photons with energies up to about 12 eV. Author (revised)

N93-28080 Arizona Univ., Tucson.
THE GALACTIC CENTER STELLAR POPULATION IN THE NEAR INFRARED Ph.D. Thesis
Joseph William Haller 1992 179 p
Avail: Univ. Microfilms Order No. DA9307651

Near infrared photometry is presented for 659 stars within 2.5 of the Galactic Center from three epochs of 2.2 microns and one epoch of 1.6 microns observations. The data were taken with a Rockwell 64 x 64 HgCdTe IR array at the Steward Observatory 1.6m telescope and are complete to m (sub k) = 11.0. Additional photometry at 3.4 microns for a subsample of 258 stars taken with a 58 x 62 InSb array at CTIO is also included. The sample has an average (H-K)(sub obs) which is consistent with a late-type population with (H-K)(sub 0) = 0.3 and A(sub V) = 31.8 mag and luminosities several magnitudes brighter than the Baade's Window AGB. A variability analysis shows 59 stars are long period variable candidates at the 3-sigma level. These stars show correlations in (H-K)(sub 0) vs. (K-L)(sub 0) and (K-L)(sub 0) vs. delta-m(sub k) consistent with Mira variables on the AGB. The LPV luminosities are consistent with a population few x 10 (exp 8) yr old which is older than the Galactic Center central cluster stars and younger than bulge stars in Baade's Window, implying the Galactic Center has repeating episodes of star formation. Observations of the CO(v = 2 yields 0) 2.3 microns absorption feature taken at the CTIO 4m with the IR Spectrometer Array of the unresolved stellar emission at 9 positions within 30 arc sec of Sgr A* are presented. It is shown that the CO band strength is highly correlated with r(sub SgrA*) for radii less than R(sub CO) is approximately equal to 8.5 arc sec (0.28 pc). Dissert. Abstr.

N93-28081 North Carolina Univ., Chapel Hill.
NUMERICAL MODELS OF PLANE-SYMMETRIC SPACETIMES WITH APPLICATIONS TO GRAVITY-WAVE COLLISIONS Ph.D. Thesis
John Edward Jaynes 1992 138 p
Avail: Univ. Microfilms Order No. DA9309897

Plane-symmetric space times, while a highly restricted subset of solutions to Einstein equations, can still behave in nontrivial and interesting ways. We construct numerical models of vacuum, plane symmetric, periodic spacetimes using the 'space plus time' or '3 plus 1' formalism. These computer programs can represent and time-evolve inhomogeneous cosmologies or gravitational waves or both. One of them uses an unrestricted diagonal 3-metric, and can represent any of the Kasner cosmologies as well as complicated gravitational wave configurations. We also apply these numerical models to study collisions of gravity waves. Analytical results show that gravitational wave pulses propagating into Minkowski space, and then colliding, form curvature singularities in 'almost all' cases. Our investigations show that wave pulses which propagate into an expanding periodic Kasner background and collide, in at least some cases, do not form singularities. Dissert. Abstr.

N93-28095# Rome Univ. (Italy). Dept. of Physics.
NEUTRINO PROPERTIES
Maurizio Lusignoli 8 Jan. 1990 15 p Presented at the Theoretical and Phenomenological Aspects of Underground Physics Workshop, Aquila Univ., Italy, 25-28 Sep. 1989 Submitted for publication
(SSCL-Preprint-722; ETN-93-93623) Avail: CASI HC A03/MF A01

Several neutrino properties were investigated by studying the neutrino flow from supernovae and from the Sun. Experimental results and the general aspects of theoretical models giving nonzero neutrino masses are summarized. The detection of neutrinos coming from the supernovae allowed the determination of limits for the neutrino mass, the charge of the electron antineutrino and for the magnetic moment of the neutrino. The smallness of the neutrino flux from the Sun introduces some difficulties in the study of its properties. The possible anticorrelation between neutrino flux and

solar activity is considered. However, the present overground experimental data are consistent with model neutrinos. ESA

N93-28143# Rome Univ. (Italy). Dept. of Physics.
QUASAR REDSHIFTS AND NON-POTENTIAL INTERACTIONS
R. Mignani (Istituto Nazionale di Fisica Nucleare, Rome, Italy.) 21 Sep. 1990 6 p Submitted for publication
(SSCL-Preprint-758; ETN-93-93650) Avail: CASI HC A02/MF A01

A possible interpretation of the large redshifts of quasars in terms of a generalized (cosmological) Doppler effect, based on the Lie-isotropic lifting of relativity (i.e., to a deformation of the space-time metric when, non-potential forces are present) is suggested. The difficulties encountered in the explanation of quasar properties arise from the interpretation of their large redshifts and attempts were made to circumvent such difficulties by a 'nearby' localization of quasars. In order to uphold a noncosmological origin of the quasar redshifts, it is necessary to invoke breakdown in quasars of conventional physical laws. The main assumption, of the possible interpretation presented, is that within quasars there act non-potential, non-Hamiltonian forces that are much stronger than those possibly also present in galaxies. ESA

N93-28202# Max-Planck-Inst. fuer Physik und Astrophysik, Garching (Germany).
A COMPARATIVE EXAMINATION OF LMC X-4 AND Her X-1 X RAY DOUBLE STAR SYSTEMS Thesis - Ludwig-Maximilians Univ. [EINE VERGLEICHENDE UNTERSUCHUNG DER ROENTGENDOPPELSTERNSYSTEM LMC X-4 UND HER X-1]
Konrad Dennerl Dec. 1991 417 p In GERMAN
(MPE-232; ETN-93-93448) Copyright Avail: CASI HC A18/MF A04

LMCX-4 and Her X-1 systems are examined from Exosat observations to understand physical phenomena such as long term effects. Qualitative results, such as rotation behavior, pulse profile, spectrum, mass transport and thirty day cycle of LMCX-4, and mass transport and thirty five day cycle of Her X-1, are obtained. The processes used for Exosat data evaluation are presented: a method was developed to distinguish recorded X-ray photons according to their energy in the x-ray spectrum examination and dead time, energy, background, position, shading and tracking corrections of counting rates were achieved. It is concluded that both systems are accretion driven stellar x-ray sources with comparable dimensions, and are neutron stars with a mass similar to compact objects. It is shown that rotation of both neutron stars is in an equilibrium state and that the time behavior of x-ray intensity is characterized by three periods. It is proved that the gravitation field of the optical companion activates spiral density waves in the accretion disks of LMCX-4 and Her X-1, which extend to the magnetosphere and are countrarotating to the trajectory around the neutron stars during long term cycle. ESA

N93-28250 South Carolina Univ., Columbia.
THE SEARCH FOR COLD DARK MATTER USING GERMANIUM DETECTORS Ph.D. Thesis
Juan Ignacio CollarColmenero 1992 290 p
Avail: Univ. Microfilms Order No. DA9307926

Data from two ultralow-background underground germanium detectors are used in a search for Cold Dark Matter (CDM) particles. The low-energy background is extensively studied, paying special attention to the cosmogenic radioisotopes produced in neutron spallation reactions. Theoretical predictions for the production rates of some isotopes of interest are obtained. Comparison with the observed rates in different detectors yields a good agreement between theory and experiment. Limits are extracted on the maximum amount of cosmogenic tritium present in the detectors. We present exclusion plots for WIMPS (Weakly Interacting Massive Particles) using conventional techniques on the data at hand. We then study the possibility of observing a unique signature from CDM by considering the effects of elastic scattering of candidate particles on the constituent nuclei of the Earth. The geology, nuclear physics, the Earth's orientation, rotation, and trajectory through the galactic halo are included, as well as the characteristic velocity distribution of CDM in the halo. Observable diurnal modulations in the detection rates and energy spectra are predicted for different particle candidates and are sought for in the data from one of the detectors. Predictions on the sensitivity of this new method in optimal geographical conditions are presented. Dissert. Abstr.

N93-28409*# Smithsonian Astrophysical Observatory, Cambridge, MA.
AN ASTROPHYSICS DATA PROGRAM INVESTIGATION OF SPATIAL STRUCTURE OF SUPERNOVA REMNANTS Final Report, 1 Aug. 1989 - 31 Jul. 1991
John P. Hughes Feb. 1993 4 p
(Grant NAG5-1180)
(NASA-CR-193104; NAS 1.26:193104) Avail: CASI HC A01/MF A01

The final report on astrophysics data program investigation of spatial structure of supernova remnants for the period 1 Aug. 1989 to 31 Jul. 1991 is presented. The goal of the project was the study of the spatial structure of supernova remnants (SNR's) as observed in the x-ray band. A number of software tools were developed for the analysis: (1) a program to fit various geometric models to high resolution x-ray data, and (2) programs for Fourier Transform analysis of clumping in SNR's. These programs were applied to high resolution imager (HRI) data on the young galactic SNR's Tycho and Kepler with some success. Author (revised)

N93-28450 Ohio State Univ., Columbus.
PHOTOEROSION IN ASTROPHYSICAL ENVIRONMENTS Ph.D. Thesis
Heidi S. Fencl 1992 163 p
Avail: Univ. Microfilms Order No. DA9307751

Photoerosion is a process by which a high energy photon interacts with a nucleus, knocking out a particle such as a proton or neutron, and leaving a smaller nucleus. This process could be capable of changing the abundances of light elements in environments with a large flux of energetic photons. One such environment is an active galactic nucleus (AGN). In this case, the abundances of isotopes of lithium, beryllium, and boron are of particular interest, as they can be produced from an abundant progenitor, carbon, and their production is interesting to studies of big bang nucleosynthesis. It was found that the production of these elements by photoerosion is potentially so large that it is possible to place limits on any AGN phase that the Milky Way may have undergone. Another type of astrophysical environment with a high photon flux is the neighborhood of a gamma-ray burster. Many theories exist as to the mechanism which causes bursts, but none is widely accepted. Therefore, any diagnostic which could provide information about a burst environment is of interest. If there are any nuclei in the region near a burster, photoerosion might provide such a diagnostic. In this case, the photoerosion products of interest are unstable nuclides, whose decay might be detected at earth. It was found that such signals are below detection limits of current instruments. However, another signal, the decay of positrons also produced by photonuclear reactions, is predicted to be observable for many parameters of the burst region. Furthermore, the strength and the time behavior of both types of signals would contain valuable information about the neighborhood near a burst, and any redshift of these signals would provide a direct measurement of the distance scale to gamma-ray. Dissert. Abstr.

N93-26690*# Arizona Univ., Tucson. Lunar and Planetary Lab.
COMPOSITION OF NEAR-EARTH ASTEROIDS
Larry A. Lebofsky *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 6 p (For primary document see N93-26674 10-91)
Avail: CASI HC A02/MF A03; 1 functional color page

N93-26691*# Arizona Univ., Tucson. Lunar and Planetary Lab.
SPACEWATCH DISCOVERY OF NEAR-EARTH ASTEROIDS
Tom Gehrels *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 7 p (For primary document see N93-26674 10-91)
Avail: CASI HC A02/MF A03; 1 functional color page

91 LUNAR AND PLANETARY EXPLORATION

Includes planetology; and manned and unmanned flights.

For spacecraft design or space stations see *18 Spacecraft Design, Testing and Performance.*

N93-26674*# Arizona Univ., Tucson. NASA Space Engineering Research Center.

NASA SPACE ENGINEERING RESEARCH CENTER FOR UTILIZATION OF LOCAL PLANETARY RESOURCES Annual Progress Report, 1 Nov. 1991 - 31 Oct. 1992

1992 308 p Original contains color illustrations

(Grant NAGw-1332)

(NASA-CR-192883; NAS 1.26:192883; APR-92) Avail: CASI HC A14/MF A03; 1 functional color page

Reports covering the period from 1 Nov. 1991 to 31 Oct. 1992 and documenting progress at the NASA Space Engineering Research Center are included. Topics covered include: (1) processing of propellants, volatiles, and metals; (2) production of structural and refractory materials; (3) system optimization discovery and characterization; (4) system automation and optimization; and (5) database development. For individual titles, see N93-26675 through N93-26699.

N93-26675*# Arizona Univ., Tucson. NASA Space Engineering Research Center.

PROPELLANT PRODUCTION AND USEFUL MATERIALS: HARDWARE DATA FROM COMPONENTS AND THE SYSTEMS **c28**

Kumar Ramohalli *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 19 p (For primary document see N93-26674 10-91)

Avail: CASI HC A03/MF A03; 1 functional color page

During the past year significant progress included: a major breakthrough in oxygen production through discs (instead of tubes) that resulted in two orders-of-magnitude increase in the yield rates, proving that oxygen production from any iron-bearing silicate (avoiding costly beneficiation) in lunar in-situ resource utilization (ISRU); construction of a half-scale robotic soil processor; production of melt-spun fibers in a solar furnace; and the culmination of first-stage research in the construction (and delivery to NASA LaRC) of a self-contained portable oxygen plant that incorporates the first generation ISRU technologies developed at UA SERC. In addition, further reductions in mass and power needs were achieved in two smaller oxygen plants, which, however, have far greater production rates. SERC continued to attract bright students both at the undergraduate and graduate levels, and several area high school students through the Professional Internship Program (PIP) administered by the local school district. Invited lectures at elementary schools continue to draw enthusiastic response. Another important first was the creation of the Freshman Colloquium, 'Space in Our Future, and Our Future in Space,' geared toward women and minority students. This course proved to be a success, with more than one-half of the enrollment composed of women. In recognition of these important contributions, the author was appointed to the NRC Committee on Space Science Technologies. Author (revised)

N93-26676*# Arizona Univ., Tucson. Dept. of Chemical Engineering.

REDUCTION OF IRON-BEARING LUNAR MINERALS FOR THE PRODUCTION OF OXYGEN **c25**

Charles Massieon, Andrew Cutler, and Farhang Shadman *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 43 p (For primary document see N93-26674 10-91)

Avail: CASI HC A03/MF A03; 1 functional color page

The kinetics and mechanism of the reduction of simulants of the iron-bearing lunar minerals olivine ((Fe,Mg)2SiO4), pyroxene ((Fe,Mg,Ca)SiO3), and ilmenite (FeTiO3) are investigated, extending previous work with ilmenite. Fayalite is reduced by H2 at 1070 K to 1480 K. A layer of mixed silica glass and iron forms around an unreacted core. Reaction kinetics are influenced by permeation of hydrogen through this layer and a reaction step involving dissociated hydrogen. Reaction mechanisms are independent of Mg content. Augite, hypersthene, and hedenbergite are reduced in H2 at the same temperatures. The products are iron metal and lower iron silicates mixed throughout the mineral. Activation energy rises with calcium content. Ilmenite and fayalite are reduced with carbon deposited on partially reduced minerals via the CO disproportionation reaction. Reduction with carbon is rapid, showing the carbothermal reduction of lunar minerals is possible. Author (revised)

N93-26677*# Arizona Univ., Tucson. Dept. of Materials Science and Engineering.

INNOVATIVE TECHNIQUES FOR THE PRODUCTION OF ENERGETIC RADICALS FOR LUNAR PROCESSING INCLUDING COLD PLASMA PROCESSING OF LOCAL PLANETARY ORES **c25**

D. Bullard and D. C. Lynch *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 8 p (For primary document see N93-26674 10-91)

Avail: CASI HC A02/MF A03; 1 functional color page

Hydrogen reduction of ilmenite has been studied by a number of investigators as a potential means for recovery of oxygen from lunar soil. Interest in this process has always rested with the simplicity of the flow diagram and the utilization of established technology. Effective utilization of hydrogen in the reduction process at temperatures of 1200 C and below has always been disappointing and, as such, has led other investigators to focus attention on other systems. Effective utilization of hydrogen in the reduction of ilmenite can be significantly enhanced in the presence of a non-equilibrium hydrogen plasma. Ilmenite at solid specimen temperatures of 600 C to 970 C were reacted in a hydrogen plasma. Those experiments revealed that hydrogen utilization can be significantly enhanced. At a specimen temperature of 850 C the fraction of H2 reacted was 24 percent compared to the 7 percent theoretical limit calculated with thermodynamic theory for the same temperature. An added advantage for a hydrogen plasma involves further reduction of TiO2. Reduction of the iron oxide in ilmenite yields TiO2 and metallic iron as by products. Titanium forms a number of oxides including TiO, Ti2O3, Ti3O5 and the Magneli oxides (Ti4O7 to Ti50O99). In conventional processing of ilmenite with hydrogen it is possible to reduce TiO2 to Ti7O13 within approximately an hour, but with poor utilization of hydrogen on the order of one mole of H2 per thousand. In the cold or non-equilibrium plasma TiO2 can be rapidly reduced to Ti2O3 with hydrogen utilization exceeding 10 percent. Based on design considerations of the plasma reactor greater utilization of the hydrogen in the reduction of TiO2 is possible. Author (revised)

N93-26678*# Washington Univ., Saint Louis, MO. Dept. of Earth and Planetary Science.

OXYGEN AND IRON PRODUCTION BY ELECTROLYTIC SMELTING OF LUNAR SOIL **c25**

R. O. Colson and L. A. Haskin *In* Arizona Univ., NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 22 p (For primary document see N93-26674 10-91)

Avail: CASI HC A03/MF A03; 1 functional color page

Work during the past year involved two aspects: (1) electrolysis experiments on a larger scale than done before, and (2) collaboration with Carbotek Inc. on design for a lunar magma electrolysis cell. It was demonstrated previously that oxygen can be produced by direct electrolysis of silicate melts. Previous experiments using 50-100 mg of melt have succeeded in measuring melt resistivities, oxygen production efficiencies, and have identified the character of metal products. A series of experiments using 1-8 grams of silicate melt, done in alumina and spinel containers sufficiently large that surface tension effects between the melt and the wall are expected to have minor effect on the behavior of the melt in the region of the electrodes were completed. The purpose of these experiments was to demonstrate the durability of the electrode and container materials, demonstrate the energy efficiency of the electrolysis process, further characterize the nature of the expected metal and spinel products, measure the efficiency of oxygen production and compare to that predicted on the basis of the smaller-scale experiments, and identify any unexpected benefits or problems of the process. Four experimental designs were employed. Detailed results of these experiments are given in the appendix ('Summary of scaling-up experiments'); a general report of the results is given in terms of implications of the experiments on container materials, cathode materials, anode materials, bubble formation and frothing of the melt, cell potential, anode-cathode distance, oxygen efficiency, and energy efficiency. Author (revised)

N93-26679*# EMEC Consultants, Export, PA.
EXPERIMENTAL STUDY OF THE ELECTROLYSIS OF SILICATE MELTS **c25**

Rudolf Keller *In* Arizona Univ., NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 10 p (For primary document see N93-26674 10-91)
Avail: CASI HC A02/MF A03; 1 functional color page

Melting and electrolyzing lunar silicates yields oxygen gas and potentially can be practiced in situ to produce oxygen. With the present experiments conducted with simulant oxides at 1425-1480 C, it was ascertained that oxygen can be obtained anodically at feasible rates and current efficiencies. An electrolysis cell was operated with platinum anodes in a sealed vessel, and the production of gas was monitored. In these electrolysis experiments, stability of anodes remained a problem, and iron and silicon did not reduce readily into the liquid silver cathode. Author (revised)

N93-26680*# Arizona State Univ., Tempe. Dept. of Geology.
LUNAR MINING OF OXYGEN USING FLUORINE **c25**

Donald M. Burt, James A. Tyburczy, Jeffery J. Roberts, and Rajan Balasubramanian *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 9 p (For primary document see N93-26674 10-91)
Avail: CASI HC A02/MF A03; 1 functional color page

Experiments during the first year of the project were directed towards generating elemental fluorine via the electrolysis of anhydrous molten fluorides. Na2SiF6 was dissolved in either molten NaBF4 or a eutectic (minimum-melting) mixture of KF-LiF-NaF and electrolyzed between 450 and 600 C to Si metal at the cathode and F2 gas at the anode. Ar gas was continuously passed through the system and F2 was trapped in a KBr furnace. Various anode and cathode materials were investigated. Despite many experimental difficulties, the capability of the process to produce elemental fluorine was demonstrated. Author (revised)

N93-26681*# Arizona Univ., Tucson. Dept. of Mining and Geological Engineering.
BENEFICIATION OF ILMENITE FROM LUMAR ANALOG **c25**

G. Ramadorai and R. Dean *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 10 p (For primary document see N93-26674 10-91)
Avail: CASI HC A02/MF A03; 1 functional color page

The results reported were obtained on a meteoric eucrite sample called Millbillillie Sample no. 173. Optical microscopy studies of the sample showed it to consist of ilmenite, troilite, and transparent gangue. The transparent gangue consisted of feldspar (anorthite), pyroxenes, olivines, and opaques. Troilite was present in minor quantities. Screen assay analyses of the 30, 100, 200, and 400 US mesh screen fractions showed that minor concentration of titanium occurred in the 200 x 400 and -400 mesh screen fractions. Scanning electron microscopy (SEM) studies of the bulk sample showed the presence of a variety of ilmenite grains, ranging from 50 microns down to less than 1 micron without any evidence of liberation. Electron Diffraction Scans (EDS) confirmed the ratio of Fe to Ti in the ilmenite grains. Dry magnetic separation in a Frantz Isodynamic Separator was found to be effective only at sizes finer than 150 microns (100 US mesh) and more so at 200 mesh (74 microns). In each case, dedusting of the sample to remove -400 mesh (-0.037 microns) fines was required. Liberation size was determined to be 200 mesh and finer. The highest grade concentrate assaying 3.45 percent Ti was produced by magnetic separation of the -200 + 400 mesh screen fraction assaying 0.44 Ti (from a -30 mesh sample) at a current setting of 0.35 AMP. This concentrate contained 21.2 percent of the Ti values in the screen fraction with 2.72 weight percent of feed to test. The results can be projected to a sample stage ground to -200 mesh. Magnetic separation of the 200 + 400 mesh (-0.074 + 0.037 microns) should produce a concentrate accounting for 1.41 weight percent of the feed. This concentrate will analyze 3.45 percent Ti and contain 10.3 percent of the Ti values in the feed. By changing the Frantz Magnetic Separator settings, a lower grade concentrate analyzing 0.98 percent Ti can be produced at an increased recovery of 25.4 percent. The concentrate weight will be 11.7 percent of the feed. It must be emphasized that improved grades and recoveries can be obtained with the -400 mesh fines. However, beneficiation of these extremely fine materials is not possible in a practical process scheme. Author (revised)

N93-26682*# Arizona Univ., Tucson. Lunar and Planetary Lab.
EXTRACTION OF VOLATILES AND METALS FROM EXTRATERRESTRIAL MATERIALS **c25**

J. S. Lewis *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 9 p (For primary document see N93-26674 10-91)
Avail: CASI HC A02/MF A03; 1 functional color page

Recent progress in defining the physical, orbital, and chemical properties of the Earth-crossing asteroid and comet population was integrated into an elaborate Monte Carlo model of the fluxes of bodies in the inner Solar System. This model is of use in projecting flight opportunities to as-yet undiscovered near-Earth objects and in assessing the impact hazard to life on Earth and the evolutionary consequences of impacts on the other terrestrial planets. Further progress was made in defining desirable transportation system architectures for the use of non-terrestrial volatiles and metals, including the delivery of propellants to near-Earth space for fueling of space exploration initiative (SEI) type expeditions, the construction and resupply of Solar Power Satellite constellations in various Earth orbits (including geosynchronous earth orbit (GEO) and Highly Eccentric Earth Orbit (HEEO)), and retrieval of He-3 for use as a clean fusion fuel on Earth. These studies suggest a greater future role for SERC in the exploration of space energy sources to meet Earth's 21st-century energy requirements. Laboratory studies of volatilization and deposition of ferrous metal alloys demonstrated deposition of strong iron films from carbonyl chemical vapor deposition (CVD), showing the crucial role of additive gases in governing the CVD process, and pointing the way to specific experiments on extraction and deposition of ferrous metals from nonterrestrial materials. Author

N93-26683*# Arizona Univ., Tucson. Dept. of Aerospace and Mechanical Engineering.
OXYGEN PRODUCTION ON MARS AND THE MOON **c31**

K. R. Sridhar, B. Vaniman, and S. Miller *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 15 p (For primary document see N93-26674 10-91)
Avail: CASI HC A03/MF A03; 1 functional color page

Significant progress was made in the area of in-situ oxygen production in the last year. In order to reduce sealing problems due to thermal expansion mismatch in the disk configuration, several all-Zirconia cells were constructed and are being tested. Two of these cells were run successfully for extended periods of time. One was run for over 200 hours and the other for over 800 hours. These extended runs, along with gas sample analysis, showed that the oxygen being produced is definitely from CO2 and not from air leaks or from the disk material. A new tube system is being constructed that is more rugged, portable, durable, and energy efficient. The important operating parameters of this system will be better controlled compared to previous systems. An electrochemical compressor will also be constructed with a similar configuration. The electrochemical compressor will use less energy since the feed stock is already heated in the separation unit. In addition, it does not have moving parts. Author

N93-26684*# Arizona Univ., Tucson. Dept. of Geosciences.
DEHYDRATION KINETICS AND THERMOCHEMISTRY OF SELECTED HYDROUS PHASES, AND SIMULATED GAS RELEASE PATTERN IN CARBONACEOUS CHONDRITES **c25**

Kunal Bose and J. Ganguly *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 14 p (For primary document see N93-26674 10-91)
Avail: CASI HC A03/MF A03; 1 functional color page

As part of our continued program of study on the volatile bearing phases and volatile resource potential of carbonaceous chondrite, results of our experimental studies on the dehydration kinetics of talc as a function of temperature and grain size (50 to 0.5 microns), equilibrium dehydration boundary of talc to 40 kbars, calorimetric study of enthalpy of formation of both natural and synthetic talc as a function of grain size, and preliminary results on the dehydration kinetics of epsomite are reported. In addition, theoretical calculations on the gas release pattern of Murchison meteorite, which is a C2(CM) carbonaceous chondrite, were performed. The kinetic study of talc leads to a dehydration rate constant for 40-50 microns size fraction of $k = (3.23 \times 10(\exp 4))\exp(-Q/RT)$/min with the activation energy $Q = 376$ (plus or minus 20) kJ/mole. The dehydration rate was found to increase somewhat with decreasing grain size. The enthalpy of formation of talc from elements was measured to be -5896(10) kJ/mol. There was

no measurable effect of grain size on the enthalpy beyond the limits of precision of the calorimetric studies. Also the calorimetric enthalpy of both synthetic and natural talc was found to be essentially the same, within the precision of measurements, although the natural talc had a slightly larger field of stability in our phase equilibrium studies. The high pressure experimental data the dehydration equilibrium of talc (talc = enstatite + coesite + H2O) is in strong disagreement with that calculated from the available thermochemical data, which were constrained to fit the low pressure experimental results. The calculated gas release pattern of Murchison meteorite were in reasonable agreement with that determined by stepwise heating in a gas chromatograph. Author (revised)

N93-26685*# Arizona Univ., Tucson. Dept. of Materials Science and Engineering.

MELT-PROCESSING OF LUNAR CERAMICS **c27**

B. D. Fabes, W. H. Poisl, D. Allen, M. Minitti, S. Hawley, and T. Beck *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 12 p (For primary document see N93-26674 10-91)

Avail: CASI HC A03/MF A03

The goal of this project is to produce useful ceramics materials from lunar resources using the by products of lunar oxygen production processes. Emphasis is being placed on both fabrication of a variety of melt-processed ceramics, and on understanding the mechanical properties of these materials. Previously, glass-ceramics were formed by casting large glass monoliths and heating these to grow small crystallites. The strengths of the resulting glass-ceramics were found to vary with the inverse square root of the crystal grain size. The highest strengths (greater than 300 MPa) were obtained with the smallest crystal sizes (less than 10 microns). During the past year, the kinetics of crystallization in simulated lunar regolith were examined in an effort to optimize the microstructure and, hence, mechanical properties of glass ceramics. The use of solar energy for melt-processing of regolith was examined, and strong (greater than 630 MPa) glass fibers were successfully produced by melt-spinning in a solar furnace. A study of the mechanical properties of simulated lunar glasses was completed during the past year. As on Earth, the presence of moisture was found to weaken simulated lunar glasses, although the effects of surface flaws was shown to outweigh the effect of atmospheric moisture on the strength of lunar glasses. The effect of atmospheric moisture on the toughness was also studied. As expected, toughness was found to increase only marginally in an anhydrous atmosphere. Finally, our efforts to involve undergraduates in the research lab fluorished this past year. Four undergraduates worked on various aspects of these projects; and two of them were co-authors on papers which we published. Author (revised)

N93-26686*# Arizona Univ., Tucson. Strategic Metals Recovery Research Facility.

RECOVERY AND SEPARATION OF PRECIOUS METALS FROM SPACE **c26**

H. Freiser and S. Muralidharan *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 3 p (For primary document see N93-26674 10-91)

Avail: CASI HC A01/MF A03; 1 functional color page

During the past year a viable procedure centered around centrifugal partition chromatography (CPC), a multistage liquid-liquid partitioning technique for the separation of precious metals (Pt, Pd, Rh, Ir, Os, Ru), was developed. Stable and inexpensive ligands that can be readily recycled to achieve the separations of the precious metals were identified. The separation methods developed so far yield three separate fractions: Pt, Pd, and Rh-Ir. The Rh-Ir pair can be separated in a subsequent run. The total amount of precious metals separated in a single experiment varied from 1 to 50 mg. The factors affecting the efficiencies of these separations were studied. The kinetics of the decomposition of the complex and the ion pair have a major bearing on these efficiencies, with slow kinetics resulting in poor efficiencies. The methods for the improvement of the efficiencies were also investigated. For example, significant improvement in the efficiencies and separation times for Pt and Pd were achieved by the use of chloride gradient in the mobile phase. Two papers were published and talks were presented on our work at the FACSS meeting in Anaheim, Oct. 1991, and at the Pittsburgh Conference in New Orleans, Mar. 1992. Author (revised)

N93-26687*# Arizona Univ., Tucson. Dept. of Civil Engineering and Engineering Mechanics.

DEVELOPMENT AND MECHANICAL PROPERTIES OF CONSTRUCTION MATERIALS FROM LUNAR SIMULANT **c31**

Chandra S. Desai *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 12 p (For primary document see N93-26674 10-91)

Avail: CASI HC A03/MF A03; 1 functional color page

Development of versatile engineering materials from locally available materials in space is an important step toward the establishment of outposts on the Moon and Mars. Development of the technologies for manufacture of structural and construction materials on the Moon, utilizing local lunar soil (regolith), without the use of water, is an important element for habitats and explorations in space. It is also vital that the mechanical behavior such as strength and tensile, flexural properties, fracture toughness, ductility, and deformation characteristics are defined toward establishment of the ranges of engineering applications of the materials developed. The objectives include two areas: (1) thermal 'liquefaction' of lunar simulant (at about 1100 C) with different additives (fibers, powders, etc.), and (2) development and use of a new triaxial test device in which lunar simulants are first compacted under cycles of loading, and then tested with different vacuums and initial confining or in situ stress. Details of the development of intermediate ceramic composites (ICC) and testing for their flexural and compression characteristics were described in various reports and papers. The subject of behavior of compacted simulant under vacuum was described in previous progress reports and publications; since the presently available device allows vacuum levels up to only 10(exp -4) torr, it is recommended that a vacuum pump that can allow higher levels of vacuum be utilized for further investigation. Author (revised)

N93-26688*# Arizona Univ., Tucson. Dept. of Materials Science and Engineering.

LAREG AREA SOLAR CELLS FROM LUNAR MATERIALS **c44**

Read Bryant, Paul Calvert, and Jean Corley *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 7 p (For primary document see N93-26674 10-91)

Avail: CASI HC A02/MF A03; 1 functional color page

The first goal of the project was to produce polymers from materials available on the Moon. This, apparently simple, aim is made complicated by the fact that there is no carbon on the Moon and there are no polymers (with a couple of irrelevant exceptions) known which do not contain carbon. Because of the abundance of silicon and oxygen in the lunar regolith, it was decided to aim to produce siloxane polymers with the (-Si-O-) backbone found in silicones. A univalent side group is also needed but there are no univalent elements available in the regolith which could plausibly make stable structures. Failing this, hydrogen is a good choice for side group since it accounts for a small fraction of the total weight of the polymer. Thus, a group of target structures such as (-SiH2-O-)n, (-Si(OH)2-O-)n is determined. This goal was approached via a series of simpler syntheses. During the first year, polydimethylsiloxane (-Si(CH3)2-O-)n was made by controlled hydrolysis of SiCl2(CH3)2, which is a routine synthesis, and then an attempt was made to make polydichlorosiloxane by controlled hydrolysis of SiCl4. At the end of the first year, some infra-red spectra indicated that this product had been obtained. Author (revised)

N93-26689*# Arizona Univ., Tucson. Planetary Image Research Lab.

DETERMINATION OF LUNAR ILMENITE ABUNDANCE FROM REMOTELY SENSED DATA

S. M. Larson, D. E. Melendrez, J. R. Johnson, and R. B. Singer *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 6 p Original contains color illustrations (For primary document see N93-26674 10-91)

Avail: CASI HC A02/MF A03; 1 functional color page

Of fundamental importance in the utilization of indigenous resources for a future permanently manned lunar base is the identification and mapping of the abundance distribution of the mineral ilmenite, which is currently considered the most readily identifiable and most easily accessible source of oxygen needed for human consumables and spacecraft propellant. Solid state detector array technology now permits the use of ground based multispectral remote sensing techniques to produce maps with better than one kilometer spatial resolution and uncertainties of about two weight-percent TiO2 abundance. An empirical relationship between the weight-percent

abundance of titanium dioxide and the 400/560 nm spectral ratio measured in returned lunar samples was used. Because this abundance correlation is valid only for mature lunar mare regolith, the distribution of immature mafic minerals which were found to be correlated primarily with steep slopes exposing bedrock was qualitatively mapped. The first mapping phase focused on the entire lunar nearside at 5.3 km per pixel, and on experiments with more sensitive spectral ratios. Relative spectrophotometry was employed to aid in identifying wavelengths that provide greater spectral contrast. It was found that the 400/730 nm ratio improved the abundance sensitivity by 37 percent, while the 950/730 nm ratio improved mafic mineral contrast about 100 percent. The second mapping phase utilized a large experimental CCD at 280 m per pixel to map the high titanium regions identified in the phase one mapping. The high resolution maps provide data on the small scale (500 m) variations in abundance and their relationship to morphological units. Author (revised)

N93-26690*# Arizona Univ., Tucson. Lunar and Planetary Lab.
COMPOSITION OF NEAR-EARTH ASTEROIDS c90
Larry A. Lebofsky *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 6 p (For primary document see N93-26674 10-91)
Avail: CASI HC A02/MF A03; 1 functional color page

The continuing goal is to determine whether any of the near-Earth asteroids or the satellites of Mars contain hydrated phyllosilicate (clay) minerals. If these minerals are present, they would provide a ready source of water for propellant generation and use in life support systems. Many of the dark main belt asteroids have been shown to contain hydrated phyllosilicate minerals. Some of the near-Earth asteroids are also dark, but telescopic detection of water on these near-Earth asteroids is complicated because of the faintness of these small asteroids and because thermal emission masks the diagnostic spectral features beyond 3 microns due to water of hydration for objects within 2 AU of the Sun. New techniques for asteroid classification based on spectral reflectance and mineralogy will be necessary to determine whether the water absorption features are present on any of the near-Earth asteroids. This past year, better ways to classify 'wet' vs. 'dry' asteroids in the main belt were looked at. This new classification may allow us to determine the presence of water of hydration in the surface minerals of near-Earth asteroids even when we can only observe them at wavelengths that are not affected by thermal emission.
Author (revised)

N93-26691*# Arizona Univ., Tucson. Lunar and Planetary Lab.
SPACEWATCH DISCOVERY OF NEAR-EARTH ASTEROIDS c90
Tom Gehrels *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 7 p (For primary document see N93-26674 10-91)
Avail: CASI HC A02/MF A03; 1 functional color page

Our overall scientific goal is to survey the solar system to completion - that is, to find the various populations and to study their statistics, interrelations, and origins. The practical benefit to SERC is that we are finding Earth-approaching asteroids that are accessible for mining. Our system can detect Earth-approachers in the 1-km size range even when they are far away, and can detect smaller objects when they are moving rapidly past Earth. Until Spacewatch, the size range of 6-300 meters in diameter for the near-Earth asteroids was unexplored. This important region represents the transition between the meteorites and the larger observed near-Earth asteroids. One of our Spacewatch discoveries, 1991 VG, may be representative of a new orbital class of object. If it is really a natural object, and not man-made, its orbital parameters are closer to those of the Earth than we have seen before; its delta V is the lowest of all objects known thus far. We may expect new discoveries as we continue our surveying, with fine-tuning of the techniques. Author (revised)

N93-26692*# Arizona Univ., Tucson. Lunar and Planetary Lab.
ABUNDANCE OF He-3 AND OTHER SOLAR-WIND-DERIVED VOLATILES IN LUNAR SOIL
Timothy D. Swindle *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 8 p (For primary document see N93-26674 10-91)
Avail: CASI HC A02/MF A03; 1 functional color page

Volatiles implanted into the lunar regolith by the solar wind are potentially important lunar resources. Wittenberg et al. (1986) have proposed that lunar He-3 could be used as a fuel for terrestrial nuclear fusion reactors. They argue that a fusion scheme involving D and He-3 would be cleaner and more efficient than currently-proposed schemes involving D and T. However, since the terrestrial inventory of He-3 is so small, they suggest that the lunar regolith, with concentrations of the order of parts per billion (by mass) would be an economical source of He-3. Solar-wind implantation is also the primary source of H, C, and N in lunar soil. These elements could also be important, particularly for life support and for propellant production. In a SERC study of the feasibility of obtaining the necessary amount of He-3, Swindle et al. (1990) concluded that the available amount is sufficient for early reactors, at least, but that the mining problems, while not necessarily insurmountable, are prodigious. The volatiles H, C, and N, on the other hand, come in parts per million level abundances. The differences in abundances mean that (1) a comparable amount of H, C, and/or N could be extracted with orders of magnitude smaller operations than required for He-3, and (2) if He-3 extraction ever becomes important, huge quantities of H, C, and N will be produced as by-products.
Author (revised)

N93-26693*# Arizona Univ., Tucson. Dept. of Electrical and Computer Engineering.
MODELING, SIMULATION, AND HIGH-AUTONOMY CONTROL OF A MARTIAN OXYGEN PRODUCTION PLANT c31
L. C. Schooley, F. E. Cellier, F.-Y. Wang, and B. P. Zeigler *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 20 p (For primary document see N93-26674 10-91)
Avail: CASI HC A03/MF A03; 1 functional color page

Progress on a project for the development of a high-autonomy intelligent command and control architecture for process plants used to produce oxygen from local planetary resources is reported. A distributed command and control architecture is being developed and implemented so that an oxygen production plant, or other equipment, can be reliably commanded and controlled over an extended time period in a high-autonomy mode with high-level task-oriented teleoperation from one or several remote locations. During the reporting period, progress was made at all levels of the architecture. At the remote site, several remote observers can now participate in monitoring the plant. At the local site, a command and control center was introduced for increased flexibility, reliability, and robustness. The local control architecture was enhanced to control multiple tubes in parallel, and was refined for increased robustness. The simulation model was enhanced to full dynamics descriptions. Author (revised)

N93-26694*# Arizona Univ., Tucson. Dept. of Aerospace and Mechanical Engineering.
DEVELOPMENT OF A MATERIAL PROCESSING PLANT FOR LUNAR SOIL c31
Ulix Goettsch and Karl Ousterhout *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 9 p (For primary document see N93-26674 10-91)
Avail: CASI HC A02/MF A03; 1 functional color page

Currently there is considerable interest in developing in-situ materials processing plants for both the Moon and Mars. Two of the most important aspects of developing such a materials processing plant is the overall system design and the integration of the different technologies into a reliable, lightweight, and cost-effective unit. The concept of an autonomous materials processing plant that is capable of producing useful substances from lunar regolith was developed. In order for such a materials processing plant to be considered as a viable option, it must be totally self-contained, able to operate autonomously, cost effective, light weight, and fault tolerant. In order to assess the impact of different technologies on the overall systems design and integration, a one-half scale model was constructed that is capable of scooping up (or digging) lunar soil, transferring the soil to a solar furnace, heating the soil in the furnace to liberate the gasses, and transferring the spent soil to a 'tile' processing center. All aspects of the control system are handled by a 386 class PC via D/A, A/D, and DSP (Digital Signal Processor) control cards. Author (revised)

N93-26695*# Environmental Research Lab., Gulf Breeze, FL.
IN-SITU MATERIALS PROCESSING SYSTEMS AND BIOREGENERATIVE LIFE SUPPORT SYSTEMS INTERRELATIONSHIPS c24
George V. Mignon and Robert J. Frye *In* Arizona Univ., NASA Space

Engineering Research Center for Utilization of Local Planetary Resources 1992 3 p (For primary document see N93-26674 10-91)
Avail: CASI HC A01/MF A03; 1 functional color page

The synergy and linkages between bioregenerative life support systems and the materials produced by in-situ materials processing systems was investigated. Such systems produce a broad spectrum of byproducts such as oxygen, hydrogen, processed soil material, ceramics, refractory, and other materials. Some of these materials may be utilized by bioregenerative systems either directly or with minor modifications. The main focus of this project was to investigate how these materials can be utilized to assist a bioregenerative life support system. Clearly the need to provide a sustainable bioregenerative life support system for long term human habitation of space is significant. Author (revised)

N93-26696*# Arizona Univ., Tucson. NASA Space Engineering Research Center.

FULL SYSTEM ENGINEERING DESIGN AND OPERATION OF AN OXYGEN PLANT **c31**

James Colvin, Paul Schallhorn, and Kumar Ramonhalli *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 17 p (For primary document see N93-26674 10-91)
Avail: CASI HC A03/MF A03; 1 functional color page

The production of oxygen from the indigenous resources on Mars is described. After discussing briefly the project's background and the experimental system design, specific experimental results of the electrolytic cell are presented. At the heart of the oxygen production system is a tubular solid zirconia electrolyte cell that will electrochemically separate oxygen from a high-temperature stream of Coleman grade carbon dioxide. Experimental results are discussed and certain system efficiencies are defined. The parameters varied include (1) the cell operating temperature; (2) the carbon dioxide flow rate; and (3) the voltage applied across the cell. The results confirm our theoretical expectations. Author (revised)

N93-26697*# Arizona Univ., Tucson. Dept. of Aerospace and Mechanical Engineering.

AN INTEGRATED DATABASE WITH SYSTEM OPTIMIZATION AND DESIGN FEATURES **c82**

A. Arabyan, P. E. Nikravesh, and T. L. Vincent *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 8 p (For primary document see N93-26674 10-91)
Avail: CASI HC A02/MF A03; 1 functional color page

A customized, mission-specific relational database package was developed to allow researchers working on the Mars oxygen manufacturing plant to enter physical description, engineering, and connectivity data through a uniform, graphical interface and to store the data in formats compatible with other software also developed as part of the project. These latter components include an optimization program to maximize or minimize various criteria as the system evolves into its final design; programs to simulate the behavior of various parts of the plant in Martian conditions; an animation program which, in different modes, provides visual feedback to designers and researchers about the location of and temperature distribution among components as well as heat, mass, and data flow through the plant as it operates in different scenarios; and a control program to investigate the stability and response of the system under different disturbance conditions. All components of the system are interconnected so that changes entered through one component are reflected in the others. Author

N93-26698*# Arizona Univ., Tucson. Steward Observatory.

THE STEWARD OBSERVATORY ASTEROID RELATIONAL DATABASE **c82**

Mark V. Sykes and Elizabeth M. AlvarezdelCastillo *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 5 p (For primary document see N93-26674 10-91)
Avail: CASI HC A01/MF A03; 1 functional color page

The Steward Observatory Asteroid Relational Database (SOARD) was created as a flexible tool for undertaking studies of asteroid populations and sub-populations, to probe the biases intrinsic to asteroid databases, to ascertain the completeness of data pertaining to specific problems, to aid in the development of observational programs, and to develop pedagogical materials. To date SOARD has compiled an extensive list of data available on asteroids and made it accessible through a single menu-driven database program. Users may obtain tailored lists of asteroid properties for any subset of asteroids or output files which are suitable for plotting spectral data on individual asteroids. A browse capability allows the user to explore the contents of any data file. SOARD offers, also, an asteroid bibliography containing about 13,000 references. The program has online help as well as user and programmer documentation manuals. SOARD continues to provide data to fulfill requests by members of the astronomical community and will continue to grow as data is added to the database and new features are added to the program. Author

N93-26699*# Planetary Science Inst., Tucson, AZ.

NEAR-EARTH ASTEROIDS: OBSERVER ALERT NETWORK AND PHYSICAL OBSERVATIONS **c82**

Donald R. Davis and Clark R. Chapman *In* Arizona Univ., NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1992 7 p (For primary document see N93-26674 10-91)
Avail: CASI HC A02/MF A03; 1 functional color page

This project strives to obtain physical observations on newly discovered Near-Earth Objects (NEO's) in order to provide fundamental data needed to assess the resources available in the population. The goal is acquiring data on all objects brighter than magnitude V= 17.0. To accomplish this, an electronic mail alert and observer information service that informs observers around the world as to the status of physical observations on currently observable NEO's was established. Such data is also acquired ourselves through a cooperative program with European colleagues that uses telescopes on La Palma to obtain spectra of NEO's and through observations made from a local telescope on Tumamoc Hill. This latter telescope has the advantage that large amounts of observing time are available, so that whenever a new NEO's discovered, we can be assured of getting time to observe it. Author

N93-27164*# Carnegie Institution of Washington, DC. Dept. of Terrestrial Magnetism.

REGIONAL TECTONIC ANALYSIS OF VENUS EQUATORIAL HIGHLANDS AND COMPARISON WITH EARTH-BASED MAGELLAN RADAR IMAGES

David R. Williams and George Wetherill 1993 16 p
(Grant NAG2-741)
(NASA-CR-192996; NAS 1.26:192996) Avail: CASI HC A03/MF A01

Research on regional tectonic analysis of Venus equatorial highlands and comparison with earth-based and Magellan radar images is presented. Over the past two years, the tectonic analysis of Venus performed centered on global properties of the planet, in order to understand fundamental aspects of the dynamics of the mantle and lithosphere of Venus. These include studies pertaining to the original constitutive and thermal character of the planet, as well as the evolution of Venus through time, and the present day tectonics. Parameterized convection models of the Earth and Venus were developed. The parameterized convection code was reformulated to model Venus with an initially hydrous mantle to determine how the cold-trap could affect the evolution of the planet. CASI

N93-27497*# Brown Univ., Providence, RI. Dept. of Geological Sciences.

EROSIONAL AND DEPOSITIONAL HISTORY OF CENTRAL CHRYSE PLANITIA Final Technical Report, 1 Sep. 1989 - 31 Oct. 1992

L. S. Crumpler 31 Oct. 1992 40 p
(Grant NAGw-2171)
(NASA-CR-193068; NAS 1.26:193068) Avail: CASI HC A03/MF A01

This map uses high resolution image data to assess the detailed depositional and erosional history of part of Chryse Planitia. This area is significant to the study of the global geology of Mars because it represents one of only two areas on the martian surface where planetary geologic mapping is assisted with 'ground truth.' In this case the ground truth was provided by Viking Lander 1. Additional questions addressed in this study are concerned with the following: the geologic context of the regional plains surface and the local surface of the Viking Lander 1 site; and the relative influence of volcanic, sedimentary, impact, aeolian, and tectonic processes at the regional and local scales. Author (revised)

N93-27604*# Martin Marietta Corp., Denver, CO. Civil Space and Communications.

MARS AQUEOUS CHEMISTRY EXPERIMENT Annual Technical Report, Jun. 1992 - Jun. 1993

Benton C. Clark and Larry W. Mason Jun. 1993 24 p Original contains color illustrations

(Contract NASw-4698)

(NASA-CR-193134; NAS 1.26:193134; MCR-93-1339) Avail: CASI HC A03/MF A01; 5 functional color pages

The Mars Aqueous Chemistry Experiment (MACE) is designed to conduct a variety of measurements on regolith samples, encompassing mineral phase analyses, chemical interactions with H2O, and physical properties determinations. From these data, much can be learned or inferred regarding the past weathering environment, the contemporaneous soil micro-environments, and the general chemical and physical state of the Martian regolith. By analyzing both soil and duricrust samples, the nature of the latter may become more apparent. Sites may be characterized for comparative purposes and criteria could be set for selection of high priority materials on future sample return missions. Progress for the first year MACE PIDDP is reported in two major areas of effort: (1) fluids handling concepts, definition, and breadboard fabrication and (2) aqueous chemistry ion sensing technology and test facility integration. A fluids handling breadboard was designed, fabricated, and tested at Mars ambient pressure. The breadboard allows fluid manipulation scenarios to be tested under the reduced pressure conditions expected in the Martian atmosphere in order to validate valve operations, orchestrate analysis sequences, investigate sealing integrity, and to demonstrate efficacy of the fluid handling concept. Additional fluid manipulation concepts have also been developed based on updated MESUR spacecraft definition. The Mars Aqueous Chemistry Experiment Ion Selective Electrode (ISE) facility was designed as a test bed to develop a multifunction interface for measurements of chemical ion concentrations in aqueous solution. The interface allows acquisition of real time data concerning the kinetics and heats of salt dissolution, and transient response to calibration and solubility events. An array of ion selective electrodes has been interfaced and preliminary calibration studies performed. Author (revised)

N93-27956*# Arizona Univ., Tucson. NASA Space Engineering Research Center.

PROCEEDINGS OF THE LUNAR MATERIALS TECHNOLOGY SYMPOSIUM

Feb. 1992 363 p Symposium held at Tuscon, AZ, 20-22 Feb. 1992

(Grant NAGw-1332)

(NASA-CR-192881; NAS 1.26:192881) Avail: CASI HC A16/MF A03

The meeting was organized around a possible lunar outpost scenario, featuring industrial technologies, systems, and components applicable to the extraction, processing, and fabrication of local materials. Acknowledged space resources experts as well as investigators from outside the field whose knowledge could be applied to space development activities were brought together. Presentations came from a variety of specialists in fields such as minerals processing, environmental control, and communications. The sessions of the symposium were divided into the following areas: resource characterization, energy management, materials processing, environment control, and automation and communications. For individual titles, see N93-27957 through N93-27988.

N93-27957*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

THE CHALLENGES AND BENEFITS OF LUNAR EXPLORATION

Aaron Cohen *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 6 p (For primary document see N93-27956 10-91)

Avail: CASI HC A02/MF A03

Three decades into the Space Age, the United States is experiencing a fundamental shift in space policy with the adoption of a broad national goal to expand human presence and activity beyond Earth orbit and out into the Solar System. These plans mark a turning point in American space exploration, for they entail a shift away from singular forays to a long-term, evolutionary program of exploration and utilization of space. No longer limited to the technical and operational specifics of any one vehicle or any one mission plan, this new approach will involve a fleet of spacecraft and a stable of off-planet research laboratories, industrial facilities, and exploration programs. The challenges inherent in this program are immense, but so too are the benefits. Central to this new space architecture is the concept of using a lunar base for in-situ resource utilization, and for the development of planetary surface exploration systems, applicable to the Moon, Mars, and other planetary bodies in the Solar System. This paper discusses the technical, economic, and political challenges involved in this new approach, and details the latest thinking on the benefits that could come from bold new endeavors on the final frontier. Author

N93-27958*# Tennessee Univ., Knoxville. Dept. of Geological Science.

RETURN TO THE MOON: LUNAR ROBOTIC SCIENCE MISSIONS

Lawrence A. Taylor *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 10 p (For primary document see N93-27956 10-91)

Avail: CASI HC A02/MF A03

There are two important aspects of the Moon and its materials which must be addressed in preparation for a manned return to the Moon and establishment of a lunar base. These involve its geologic science and resource utilization. Knowledge of the Moon forms the basis for interpretations of the planetary science of the terrestrial planets and their satellites; and there are numerous exciting explorations into the geologic science of the Moon to be conducted using orbiter and lander missions. In addition, the rocks and minerals and soils of the Moon will be the basic raw materials for a lunar outpost; and the In-Situ Resource Utilization (ISRU) of lunar materials must be considered in detail before any manned return to the Moon. Both of these fields -- planetary science and resource assessment -- will necessitate the collection of considerable amounts of new data, only obtainable from lunar-orbit remote sensing and robotic landers. For over fifteen years, there have been a considerable number of workshops, meetings, etc. with their subsequent 'white papers' which have detailed plans for a return to the Moon. The Lunar Observer mission, although grandiose, seems to have been too expensive for the austere budgets of the last several years. However, the tens of thousands of man-hours that have gone into 'brainstorming' and production of plans and reports have provided the precursor material for today's missions. It has been only since last year (1991) that realistic optimism for lunar orbiters and soft landers has come forth. Plans are for 1995 and 1996 'Early Robotic Missions' to the Moon, with the collection of data necessary for answering several of the major problems in lunar science, as well as for resource and site evaluation, in preparation for soft landers and a manned-presence on the Moon Author (revised)

N93-27959*# BDM International, Inc., Albuquerque, NM.

CHARACTERIZATION OF LUNAR SURFACE MATERIALS FOR USE IN CONSTRUCTION

Stewart W. Johnson and Jack O. Burns (New Mexico State Univ., Las Cruces.) *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 6 p (For primary document see N93-27956 10-91)

Avail: CASI HC A02/MF A03

The Workshop on the Concept of a Common Lunar Lander, which was held at the NASA Johnson Space Center on July 1 and 2, 1991, discussed potential payloads to be placed on the Moon by a common, generic, unmanned, vehicle beginning late in this decade. At this workshop, a variety of payloads were identified including a class of one-meter (and larger) optical telescopes to operate on the lunar surface. These telescopes for lunar-based astronomy are presented in an earlier section of this report. The purpose of this section is to suggest that these and other payloads for the Common Lunar Lander be used to facilitate technology development for the proposed 16-meter Aperture UV/Visible/IR Large Lunar Telescope (LLT) and a large optical aperture-synthesis instrument analogous to the Very Large Array of the National Radio Astronomy Observatory. Author (revised)

N93-27960*# Bechtel National, Inc., San Francisco, CA.

AN ENGINEER/CONSTRUCTOR'S VIEW OF LUNAR RESOURCE DEVELOPMENT Abstract only

Carleton H. Jones *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 1 p (For primary document see N93-27956 10-91)

Avail: CASI HC A01/MF A03

A strawman lunar outpost scenario has been postulated as a special

focus to guide the papers in this symposium. This scenario describes an evolving facility with basic components, personnel, and activities intended to support lunar missions that lead to a permanent occupation on the lunar surface. The engineer/constructor's view of establishing a lunar outpost is largely concerned with identifying and analyzing the logistics needed to transform the engineering designs on paper into a constructed and operating facility. This means that all aspects of the outpost design will be examined to satisfy constructability requirements and to develop a construction management plan that leads to successful facility startup and routine operations. Whether the facility is to be devoted to materials production, vehicle refueling, or science projects will influence the construction plan in its details, but the construction of all lunar facilities will be mainly governed by the difficult logistics path from Earth to the lunar surface.

Author (revised)

N93-27961*# Little (Arthur D.), Inc., Boston, MA.

ENERGY FOR LUNAR RESOURCE EXPLOITATION

Peter E. Glaser *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 8 p (For primary document see N93-27956 10-91)

Avail: CASI HC A02/MF A03

Humanity stands at the threshold of exploiting the known lunar resources that have opened up with the access to space. America's role in the future exploitation of space, and specifically of lunar resources, may well determine the level of achievement in technology development and global economic competition. Space activities during the coming decades will significantly influence the events on Earth. The 'shifting of history's tectonic plates' is a process that will be hastened by the increasingly insistent demands for higher living standards of the exponentially growing global population. Key to the achievement of a peaceful world in the 21st century, will be the development of a mix of energy resources at a societally acceptable and affordable cost within a realistic planning horizon. This must be the theme for the globally applicable energy sources that are compatible with the Earth's ecology. It is in this context that lunar resources development should be a primary goal for science missions to the Moon, and for establishing an expanding human presence. The economic viability and commercial business potential of mining, extracting, manufacturing, and transporting lunar resource based materials to Earth, Earth orbits, and to undertake macroengineering projects on the Moon remains to be demonstrated. These extensive activities will be supportive of the realization of the potential of space energy sources for use on Earth. These may include generating electricity for use on Earth based on beaming power from Earth orbits and from the Moon to the Earth, and for the production of helium 3 as a fuel for advanced fusion reactors. Author (revised)

N93-27962*# Boeing Electronics High Technology Center, Seattle, WA.

ADVANCED PHOTOVOLTAIC POWER SYSTEMS USING TANDEM GaAs/GaSb CONCENTRATOR MODULES **c44**

L. M. Fraas, M. S. Kuryla, D. A. Pietila, V. S. Sundaram, P. E. Gruenbaum, J. E. Avery, V. Dihn, R. Ballantyne, and C. Samuel *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 13 p (For primary document see N93-27956 10-91)

Avail: CASI HC A03/MF A03

In 1989, Boeing announced the fabrication of a tandem gallium concentrator solar cell with an energy conversion efficiency of 30 percent. This research breakthrough has now led to panels which are significantly smaller, lighter, more radiation resistant, and potentially less expensive than the traditional silicon flat plate electric power supply. The new Boeing tandem concentrator (BTC) module uses an array of lightweight silicone Fresnel lenses mounted on the front side of a light weight aluminum honeycomb structure to focus sunlight onto small area solar cells mounted on a thin back plane. This module design is shown schematically. The tandem solar cell in this new module consists of a gallium arsenide light sensitive cell with a 24 percent energy conversion efficiency stacked on top of a gallium antimonide infrared sensitive cell with a conversion efficiency of 6 percent. This gives a total efficiency 30 percent for the cell-stack. The lens optical efficiency is typically 85 percent. Discounting for efficiency losses associated with lens packing, cell wiring, and cell operating temperature still allows for a module efficiency of 22 percent which leads to a module power density of 300 Watts/sq. m. This performance provides more than twice the power density available from a single crystal silicon flat plate module and at least four times the power density available from amorphous silicon modules. The fact that the lenses are only 0.010 ft. thick and the aluminum foil back plane is only 0.003 ft. thick leads to a very lightweight module. Although the cells are an easy to handle thickness of 0.020 ft., the fact that they are small, occupying one-twenty-fifth of the module area, means that they add little to the module weight. After summing all the module weights and given the high module power, we find that we are able to fabricate BTC modules with specific power of 100 watts/kg.

Author (revised)

N93-27963*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

AN EVOLUTION STRATEGY FOR LUNAR NUCLEAR SURFACE POWER **c20**

Lee S. Mason *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 14 p (For primary document see N93-27956 10-91)

Avail: CASI HC A03/MF A03

The production and transmission of electric power for a permanently inhabited lunar base poses a significant challenge which can best be met through an evolution strategy. Nuclear systems offer the best opportunity for evolution in terms of both life and performance. Applicable nuclear power technology options include isotope systems (either radioisotope thermoelectric generators or dynamic isotope power systems) and reactor systems with either static (thermoelectric or thermionic) or dynamic (Brayton, Stirling, Rankine) conversion. A power system integration approach that takes evolution into account would benefit by reduced development and operations cost, progressive flight experience, and simplified logistics, and would permit unrestrained base expansion. For the purposes of defining a nuclear power system evolution strategy, the lunar base development shall consist of four phases: precursor, emplacement, consolidation, and operations. Author (revised)

N93-27964*# National Aeronautics and Space Administration, Washington, DC.

EARTH TO SPACE POWER BEAMING: A NEW NASA TECHNOLOGY INITIATIVE Abstract only **c20**

John D. G. Rather *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 1 p (For primary document see N93-27956 10-91)

Avail: CASI HC A01/MF A03

Laser power beaming from the Earth's surface is an innovative and potentially cost-effective option for reliably providing electrical power for applications such as space transportation, Earth-orbiting satellites, and lunar development. The maturation of laser power beaming technology can support low power applications such as upgraded conventional communications satellites in the present decade. Power beaming systems to support extensive lunar base operations that may consume extremely large amounts of power can be implemented early in the 21st century. The synergistic advantages of high-thrust, high specific-impulse electric propulsion may make enhanced, low cost space logistics an area of unique significance for laser power beaming. Economic forces will continue as a driving factor in the selection of major system elements for both commercial applications as well as the avant-garde national space missions envisioned for the 21st century. As a result, the implementation of laser power beaming systems will only take place if they can demonstrate clear economic benefits without sacrificing performance, personnel safety, or the environment. Similarly, the development activities that are a necessary precursor to any operational system will take place only if key industry and government leaders perceive laser power beaming systems as an achievable goal with realistic payoffs in comparison to competing energy options. This paper summarizes NASA's current research to evaluate laser power beaming systems as they apply to applications of greatest interest, and it includes a summary of the current laser power beaming program within the NASA Headquarters Office of Aeronautics and Space Technology. This research effort will quantify some key technical certainties and uncertainties pertaining to laser power beaming systems appropriate for space applications as well as establish a path of development that includes maturation of key technology components for reliable laser and millimeter wave power beaming systems during the 1990's. The program is known as 'SELENE', an acronym for Space Laser Energy. Author (revised)

N93-27965*# International Fuel Cells Corp., South Windsor, CT.
FUEL CELL TECHNOLOGY FOR LUNAR SURFACE OPERATIONS c44
Henry J. DeRonck *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 4 p (For primary document see N93-27956 10-91)
Avail: CASI HC A01/MF A03

Hydrogen-oxygen fuel cells have been shown, in several NASA and contractor studies, to be an enabling technology for providing electrical power for lunar bases, outposts, and vehicles. The fuel cell, in conjunction with similar electrolysis cells, comprises a closed regenerative energy storage system, commonly referred to as a regenerative fuel cell (RFC). For stationary applications, energy densities of 1,000 watt-hours per kilograms an order of magnitude over the best rechargeable batteries, have been projected. In this RFC, the coupled fuel cell and electrolyzer act as an ultra-light battery. Electrical energy from solar arrays 'charges' the system by electrolyzing water into hydrogen and oxygen. When an electrical load is applied, the fuel cell reacts the hydrogen and oxygen to 'discharge' usable power. Several concepts for utilizing RFC's, with varying degrees of integration, have been proposed, including both primary and backup roles. For mobile power needs, such as rovers, an effective configuration may be to have only the fuel cell located on the vehicle, and to use a central electrolysis 'gas station'. Two fuel cell technologies are prime candidates for lunar power system concepts: alkaline electrolyte and proton exchange membrane. Alkaline fuel cells have been developed to a mature production power unit in NASA's Space Shuttle Orbiter. Recent advances in materials offer to significantly improve durability to the level needed for extended lunar operations. Proton exchange membrane fuel cells are receiving considerable support for hydrospace and terrestrial transportation applications. This technology promises durability, simplicity, and flexibility.
Author (revised)

N93-27966*# Boeing Defense and Space Group, Huntsville, AL.
ELECTRICAL POWER INTEGRATION FOR LUNAR OPERATIONS c20
Gordon Woodcock *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 15 p (For primary document see N93-27956 10-91)
Avail: CASI HC A03/MF A03

Electrical power for future lunar operations is expected to range from a few kilowatts for an early human outpost to many megawatts for industrial operations in the 21st century. All electrical power must be imported as chemical, solar, nuclear, or directed energy. The slow rotation of the Moon and consequent long lunar night impose severe mass penalties on solar systems needing night delivery from storage. The cost of power depends on the cost of the power systems the cost of its transportation to the Moon, operating cost, and, of course, the life of the power system. The economic feasibility of some proposed lunar ventures depends in part on the cost of power. This paper explores power integration issues, costs, and affordability in the context of the following representative lunar ventures: (1) early human outpost (10 kWe); (2) early permanent lunar base, including experimental ISMU activities (100 kWe); (3) lunar oxygen production serving an evolved lunar base (500 kWe); (4) lunar base production of specialized high-value products for use on Earth (5 kWe); and (5) lunar mining and production of helium-3 (500 kWe). The schema of the paper is to project likely costs of power alternatives (including integration factors) in these power ranges, to select the most economic, to determine power cost contribution to the product or activities, to estimate whether the power cost is economically acceptable, and, finally, to offer suggestions for reaching acceptability where cost problems exist. Author (revised)

N93-27967*# Bechtel National, Inc., San Francisco, CA.
OXYGEN PRODUCTION ON THE LUNAR MATERIALS PROCESSING FRONTIER c54
Barbara H. Altenberg *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 14 p (For primary document see N93-27956 10-91)
Avail: CASI HC A03/MF A03

During the pre-conceptual design phase of an initial lunar oxygen processing facility, it is essential to identify and compare the available processes and evaluate them in order to ensure the success of such an endeavor. The focus of this paper is to provide an overview of materials processing to produce lunar oxygen as one part of a given scenario of a developing lunar occupation. More than twenty-five techniques to produce oxygen from lunar materials have been identified. While it is important to continue research on any feasible method, not all methods can be implemented at the initial lunar facility. Hence, it is necessary during the pre-conceptual design phase to evaluate all methods and determine the leading processes for initial focus. Researchers have developed techniques for evaluating the numerous proposed methods in order to suggest which processes would be best to go to the Moon first. As one section in this paper, the recent evaluation procedures that have been presented in the literature are compared and contrasted. In general, the production methods for lunar oxygen fall into four categories: thermochemical, reactive solvent, pyrolytic, and electrochemical. Examples from two of the four categories are described, operating characteristics are contrasted, and terrestrial analogs are presented when possible. In addition to producing oxygen for use as a propellant and for life support, valuable co-products can be derived from some of the processes. This information is also highlighted in the description of a given process. Author (revised)

N93-27968*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
MAGNETIC BENEFICIATION OF LUNAR SOILS
D. S McKay, R. R. Oder (Exportech Co., Inc., New Kensington, PA.), J. Graf (Michigan Technological Univ., Houghton.), and L. A. Taylor (Tennessee Univ., Knoxville.) *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 9 p (For primary document see N93-27956 10-91)
Avail: CASI HC A02/MF A03

We will present a review of recent laboratory results obtained in dry magnetic separation of one gram samples of the minus 1 mm size fraction of five lunar soils of widely differing maturities. Two highland soils were investigated as potential sources of low iron content feed stocks for space manufacture of metals, including aluminum, silicon, and calcium. Pure anorthite was separated from the diamagnetic fraction of immature highland regolith. Three high titanium mare soils were investigated as potential sources of ilmenite for production of hydrogen and for recovery of He-3. Ilmenite and pyroxene were separated from the paramagnetic fractions of the mare basalts. Agglutinates and other fused soil components containing metallic iron were separated from the strongly magnetic fractions of all soils. We will present conceptual magnetic separation flow sheets developed from the laboratory data and designed for production of anorthite from highland soils and for production of ilmenite from mare soils. Using these flow sheets, we will discuss problems and opportunities associated with the magnetic separation of lunar soils. Separation of high-grade anorthite or other diamagnetic components at moderately high recovery can be achieved in processing immature highland soils. Further, while magnet weight is always an issue in magnetic separation technology, recent developments in both low temperature and high temperature superconductivity present unusual opportunities for magnet design specific to the lunar environment.
Author (revised)

N93-27969*# Arizona Univ., Tucson. NASA Space Engineering Resarch Center.
PROPELLANT PRODUCTION AND USEFUL MATERIALS: HARDWARE DATA FROM COMPONENTS AND THE SYSTEMS c28
Kumar Ramohalli *In its* Proceedings of the Lunar Materials Technology Symposium Feb. 1992 17 p (For primary document see N93-27956 10-91)
Avail: CASI HC A03/MF A03

Research activities at the University of Arizona/NASA Space Engineering Research Center are described; the primary emphasis is on hardware development and operation. The research activities are all aimed toward introducing significant cost reductions through the utilization of resources locally available at extraterrestrial sites. The four logical aspects include lunar, Martian, support, and common technologies. These are described in turn. The hardware realizations are based upon sound scientific principles which are used to screen a host of interesting and novel concepts. Small scale feasibility studies are used as the screen to allow only the most promising concepts to proceed. Specific examples include: kg/day-class oxygen plant that uses CO2 as the feed stock, spent stream utilization to produce methane and 'higher' compounds (using hydrogen from a water electrolysis plant), separation of CO from the CO2, reduction of any iron bearing silicate (lunar soils), production of structural components, smart sensors and autonomous controls, and quantitative computer simulation of

extraterrestrial plants. The most important feature of all this research continues to be the training of high-quality students for our future in space. Author (revised)

N93-27970*# Electrochemical Technology Corp., Seattle, WA.
METALS PRODUCTION
Theodore S. Beck *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 13 p (For primary document see N93-27956 10-91)
Avail: CASI HC A03/MF A03

Existing procedures for design of electrochemical plants can be used for design of lunar processes taking into consideration the differences in environmental conditions. These differences include: 1/6 Earth gravity, high vacuum, solar electrical and heat source, space radiation heat sink, long days and nights, and different availability and economics of materials, energy, and labor. Techniques have already been developed for operation of relatively small scale hydrogen-oxygen fuel cell systems used in the U.S. lunar landing program. Design and operation of lunar aqueous electrolytic process plants appears to be within the state-of-the-art. Finding or developing compatible materials for construction and designing of fused-magma metal winning cells will present a real engineering challenge. Author (revised)

N93-27971*# Corning Glass Works, NY.
GLASSES, CERAMICS, AND COMPOSITES FROM LUNAR MATERIALS
George H. Beall *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 13 p (For primary document see N93-27956 10-91)
Avail: CASI HC A03/MF A03

A variety of useful silicate materials can be synthesized from lunar rocks and soils. The simplest to manufacture are glasses and glass-ceramics. Glass fibers can be drawn from a variety of basaltic glasses. Glass articles formed from titania-rich basalts are capable of fine-grained internal crystallization, with resulting strength and abrasion resistance allowing their wide application in construction. Specialty glass-ceramics and fiber-reinforced composites would rely on chemical separation of magnesium silicates and aluminosilicates as well as oxides titania and alumina. Polycrystalline enstatite with induced lamellar twinning has high fracture toughness, while cordierite glass-ceramics combine excellent thermal shock resistance with high flexural strengths. If sapphire or rutile whiskers can be made, composites of even better mechanical properties are envisioned. Author (revised)

N93-27972*# Boeing Defense and Space Group, Seattle, WA.
LUNAR MATERIALS PROCESSING SYSTEM INTEGRATION c31
Brent Sherwood *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 13 p (For primary document see N93-27956 10-91)
Avail: CASI HC A03/MF A03

The theme of this paper is that governmental resources will not permit the simultaneous development of all viable lunar materials processing (LMP) candidates. Choices will inevitably be made, based on the results of system integration trade studies comparing candidates to each other for high-leverage applications. It is in the best long-term interest of the LMP community to lead the selection process itself, quickly and practically. The paper is in five parts. The first part explains what systems integration means and why the specialized field of LMP needs this activity now. The second part defines the integration context for LMP -- by outlining potential lunar base functions, their interrelationships and constraints. The third part establishes perspective for prioritizing the development of LMP methods, by estimating realistic scope, scale, and timing of lunar operations. The fourth part describes the use of one type of analytical tool for gaining understanding of system interactions: the input/output model. A simple example solved with linear algebra is used to illustrate. The fifth and closing part identifies specific steps needed to refine the current ability to study lunar base system integration. Research specialists have a crucial role to play now in providing the data upon which this refinement process must be based. Author (revised)

N93-27973*# Aerojet TechSystems Co., Sacramento, CA.
ON-SITE MANUFACTURE OF PROPELLANT OXYGEN FROM LUNAR RESOURCES c31
Sanders D. Rosenberg *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 11 p (For primary document see N93-27956 10-91)
Avail: CASI HC A03/MF A03

The Aerojet Carbothermal Process for the manufacture of oxygen from lunar resources has three essential steps: the reduction of silicate with methane to form carbon monoxide and hydrogen; the reduction of carbon monoxide with hydrogen to form methane and water; and the electrolysis of water to form oxygen and hydrogen. This cyclic process does not depend upon the presence of water or water precursors in the lunar materials; it will produce oxygen from silicates regardless of their precise composition and fine structure. Research on the first step of the process was initiated by determining some of the operating conditions required to reduce igneous rock with carbon and silicon carbide. The initial phase of research on the second step is completed; quantitative conversion of carbon monoxide and hydrogen to methane and water was achieved with a nickel-on-kieselguhr catalyst. The equipment used in and the results obtained from these process studies are reported in detail. Author (revised)

N93-27974*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
OPTIONS FOR A LUNAR BASE SURFACE ARCHITECTURE
Barney B. Roberts *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 15 p (For primary document see N93-27956 10-91)
Avail: CASI HC A03/MF A03

The Planet Surface Systems Office at the NASA Johnson Space Center has participated in an analysis of the Space Exploration Initiative architectures described in the Synthesis Group report. This effort involves a Systems Engineering and Integration effort to define point designs for evolving lunar and Mars bases that support substantial science, exploration, and resource production objectives. The analysis addresses systems-level designs; element requirements and conceptual designs; assessments of precursor and technology needs; and overall programmatics and schedules. This paper focuses on the results of the study of the Space Resource Utilization Architecture. This architecture develops the capability to extract useful materials from the indigenous resources of the Moon and Mars. On the Moon, a substantial infrastructure is emplaced which can support a crew of up to twelve. Two major process lines are developed: one produces oxygen, ceramics, and metals; the other produces hydrogen, helium, and other volatiles. The Moon is also used for a simulation of a Mars mission. Significant science capabilities are established in conjunction with resource development. Exploration includes remote global surveys and piloted sorties of local and regional areas. Science accommodations include planetary science, astronomy, and biomedical research. Greenhouses are established to provide a substantial amount of food needs. Author (revised)

N93-27975*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
ENGINEERING DESIGN CONSTRAINTS OF THE LUNAR SURFACE ENVIRONMENT Abstract only c31
D. A. Morrison *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 2 p (For primary document see N93-27956 10-91)
Avail: CASI HC A01/MF A03

Living and working on the lunar surface will be difficult. Design of habitats, machines, tools, and operational scenarios in order to allow maximum flexibility in human activity will require paying attention to certain constraints imposed by conditions at the surface and the characteristics of lunar material. Primary design drivers for habitat, crew health and safety, and crew equipment are: ionizing radiation, the meteoroid flux, and the thermal environment. Secondary constraints for engineering derive from: the physical and chemical properties of lunar surface materials, rock distributions and regolith thicknesses, topography, electromagnetic properties, and seismicity. Protection from ionizing radiation is essential for crew health and safety. The total dose acquired by a crew member will be the sum of the dose acquired during EVA time (when shielding will be least) plus the dose acquired during time spent in the habitat (when shielding will be maximum). Minimizing the dose acquired in the habitat extends the time allowable for EVA's before a dose limit is reached. Habitat shielding is enabling, and higher precision in predicting secondary fluxes produced in shielding material would be desirable. Means for minimizing dose during a solar flare event while on extended EVA will be essential. Early warning

of the onset of flare activity (at least a half-hour is feasible) will dictate the time available to take mitigating steps. Warning capability affects design of rovers (or rover tools) and site layout. Uncertainty in solar flare timing is a design constraint that points to the need for quickly accessible or constructible safe havens. Author (revised)

N93-27976*# Arizona Univ., Tucson. Environmental Research Lab.
CLOSED ECOLOGICAL SYSTEMS: FROM TEST TUBES TO EARTH'S BIOSPHERE **c54**
Robert J. Frye and George Mignon *In its* Proceedings of the Lunar Materials Technology Symposium Feb. 1992 19 p (For primary document see N93-27956 10-91)
Avail: CASI HC A03/MF A03

Artificially constructed closed ecological systems (CES) have been researched both experimentally and theoretically for over 25 years. The size of these systems have varied from less than one liter to many thousands of cubic meters in volume. The diversity of the included components has a similarly wide range from purely aquatic systems to soil based systems that incorporate many aspects of Earth's biosphere. While much has been learned about the functioning of these closed systems, much remains to be learned. In this paper, we compare and contrast the behavior of closed ecological systems of widely different sizes through an analysis of their atmospheric composition. In addition, we will compare the performance of relatively small CES with the behavior of Earth's biosphere. We address the applicability of small CES as replicable analogs for planetary biospheres and discuss the use of small CES as an experimental milieu for an examination of the evolution of extra-terrestrial colonies. Author (revised)

N93-27977*# United Technologies Corp., Farmington, CT. Hamilton Standard Div.
SPE WATER ELECTROLYZERS IN SUPPORT OF THE LUNAR OUTPOST **c54**
J. F. McElroy *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 20 p (For primary document see N93-27956 10-91)
Avail: CASI HC A03/MF A03

During the 1970s, the SPE water electrolyzer, which uses ion exchange membranes as its sole electrolyte, was developed for nuclear submarine metabolic oxygen production. These developments included SPE water electrolyzer operation at up to 3,000 psia and at current densities in excess of 1,000 amps per square foot. The SPE water electrolyzer system is now fully qualified for both the U.S. and U.K. Navies with tens of thousands of system hours accumulated at sea. During the 1980s, the basic SPE water electrolyzer cell structure developed for the Navies was incorporated into several demonstrations for NASA's Space Station Program. Among these were: the SPE regenerative fuel cell for electrical energy storage; the SPE water electrolyzer for metabolic oxygen production; and the high pressure SPE water electrolyzer for reboost propulsion reactant production. In the 1990s, one emphasis will be the development of SPE water electrolyzers for the Lunar Outposts Currently defined potential Lunar Outpost applications for the SPE water electrolyzer include: SPE water electrolyzers for metabolic oxygen and potable water production from reclaimed water; and SPE water electrolyzers operating at high pressure as part of stationary and mobile surface energy storage systems. Author (revised)

N93-27978*# Lockheed Engineering and Sciences Co., Houston, TX. Life Support Development Lab.
ASSESSMENT OF THE STATE OF THE ART IN LIFE SUPPORT ENVIRONMENTAL CONTROL FOR SEI **c54**
Charles H. Simonds and Gary P. Noyes *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 14 p (For primary document see N93-27956 10-91)
Avail: CASI HC A03/MF A03

This paper defines the types of technology that would be used in a lunar base for environmental control and life support system and how it might relate to in situ materials utilization (ISMU) for the Space Exploration Initiative (SEI). There are three types of interaction between ISMU and the Environmental Control and Life Support System (ECLSS): (1) ISMU can reduce cost of water, oxygen, and possibly diluent gasses provided to ECLSS--a corollary to this fact is that the availability of indigenous resources can dramatically alter life support technology trade studies; (2) ISMU can use ECLSS waste systems as a source of reductant carbon and hydrogen; and (3) ECLSS and ISMU, as two chemical processing technologies used in spacecraft, can share technology, thereby increasing the impact of technology investments in either area. Author (revised)

N93-27979*# AiResearch Mfg. Co., Los Angeles, CA.
DUST PROTECTION FOR ENVIRONMENTAL CONTROL AND LIFE SUPPORT SYSTEMS IN THE LUNAR ENVIRONMENT **c54**
Susan Fuhs and Jeffrey Harris (Lockheed Corp., Houston, TX.) *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 12 p (For primary document see N93-27956 10-91)
Avail: CASI HC A03/MF A03

Lunar dust is pervasive, and requirements for dust protection will affect both hardware design and operations planning for lunar surface systems. On Earth, mechanical problems caused by particulates include erosive and abrasive effects, clogging of mechanical equipment, and impairment of seals and bonds. In addition, dust tends to degrade the heat rejection properties of contaminated surfaces. All these effects have been observed on the lunar surface as well. This paper discusses the potential applicability of current dust protection methods to the problem of dust protection for the environmental control and life support (ECLS) systems of a lunar base, and highlights areas where development may be necessary. A review of dust problems experienced during the Apollo missions and of additional, ground-based experience with lunar dust provides a baseline for identifying operations and areas where dust may be expected to affect the ECLS systems. Current Earth-based methods of dust protection are identified and the impact of differences between the Earth and lunar environments on these methods is evaluated. Finally, integration of dust protection equipment with ECLS systems equipment is discussed. Author (revised)

N93-27980*# National Inst. of Standards and Technology, Gaithersburg, MD.
INTELLIGENT ROBOTS FOR PLANETARY EXPLORATION AND CONSTRUCTION **c37**
James S. Albus *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 15 p (For primary document see N93-27956 10-91)
Avail: CASI HC A03/MF A03

Robots capable of practical applications in planetary exploration and construction will require realtime sensory-interactive goal-directed control systems. A reference model architecture based on the NIST Real-time Control System (RCS) for real-time intelligent control systems is suggested. RCS partitions the control problem into four basic elements: behavior generation (or task decomposition), world modeling, sensory processing, and value judgment. It clusters these elements into computational nodes that have responsibility for specific subsystems, and arranges these nodes in hierarchical layers such that each layer has characteristic functionality and timing. Planetary exploration robots should have mobility systems that can safely maneuver over rough surfaces at high speeds. Walking machines and wheeled vehicles with dynamic suspensions are candidates. The technology of sensing and sensory processing has progressed to the point where real-time autonomous path planning and obstacle avoidance behavior is feasible. Map-based navigation systems will support long-range mobility goals and plans. Planetary construction robots must have high strength-to-weight ratios for lifting and positioning tools and materials in six degrees-of-freedom over large working volumes. A new generation of cable-suspended Stewart platform devices and inflatable structures are suggested for lifting and positioning materials and structures, as well as for excavation, grading, and manipulating a variety of tools and construction machinery. Author (revised)

N93-27981*# Intec Controls Corp., Walpole, MA.
FLEXIBLE CONTROL TECHNIQUES FOR A LUNAR BASE **c63**
Thomas W. Kraus *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 8 p (For primary document see N93-27956 10-91)
Avail: CASI HC A02/MF A03

The fundamental elements found in every terrestrial control system can be employed in all lunar applications. These elements include sensors which measure physical properties, controllers which acquire sensor data and calculate a control response, and actuators which apply the control output to the process. The unique characteristics of the lunar environment

will certainly require the development of new control system technology. However, weightlessness, harsh atmospheric conditions, temperature extremes, and radiation hazards will most significantly impact the design of sensors and actuators. The controller and associated control algorithms, which are the most complex element of any control system, can be derived in their entirety from existing technology. Lunar process control applications -- ranging from small-scale research projects to full-scale processing plants -- will benefit greatly from the controller advances being developed today. In particular, new software technology aimed at commercial process monitoring and control applications will almost completely eliminate the need for custom programs and the lengthy development and testing cycle they require. The applicability of existing industrial software to lunar applications has other significant advantages in addition to cost and quality. This software is designed to run on standard hardware platforms and takes advantage of existing LAN and telecommunications technology. Further, in order to exploit the existing commercial market, the software is being designed to be implemented by users of all skill levels -- typically users who are familiar with their process, but not necessarily with software or control theory. This means that specialized technical support personnel will not need to be on-hand, and the associated costs are eliminated. Finally, the latest industrial software designed for the commercial market is extremely flexible, in order to fit the requirements of many types of processing applications with little or no customization. This means that lunar process control projects will not be delayed by unforeseen problems or last minute process modifications. The software will include all of the tools needed to adapt to virtually any changes. In contrast to other space programs which required the development of tremendous amounts of custom software, lunar-based processing facilities will benefit from the use of existing software technology which is being proven in commercial applications on Earth.

Author (revised)

N93-27982*# Westinghouse Electric Corp., Madison, PA.

THE USE OF AUTOMATION AND ROBOTIC SYSTEMS TO ESTABLISH AND MAINTAIN LUNAR BASE OPERATIONS **c63**

Lyman J. Petrosky *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 6 p (For primary document see N93-27956 10-91)

Avail: CASI HC A02/MF A03

Robotic systems provide a means of performing many of the operations required to establish and maintain a lunar base. They form a synergistic system when properly used in concert with human activities. This paper discusses the various areas where robotics and automation may be used to enhance lunar base operations. Robots are particularly well suited for surface operations (exterior to the base habitat modules) because they can be designed to operate in the extreme temperatures and vacuum conditions of the Moon (or Mars). In this environment, the capabilities of semi-autonomous robots would surpass that of humans in all but the most complex tasks. Robotic surface operations include such activities as long range geological and mineralogical surveys with sample return, materials movement in and around the base, construction of radiation barriers around habitats, transfer of materials over large distances, and construction of outposts. Most of the above operations could be performed with minor modifications to a single basic robotic rover. Within the lunar base habitats there are a few areas where robotic operations would be preferable to human operations. Such areas include routine inspections for leakage in the habitat and its systems, underground transfer of materials between habitats, and replacement of consumables. In these and many other activities, robotic systems will greatly enhance lunar base operations. The robotic systems described in this paper are based on what is realistically achievable with relatively near term technology. A lunar base can be built and maintained if we are willing. Author (revised)

N93-27983*# General Communication, Inc., Anchorage, AK.

CONSIDERATIONS FOR LUNAR COLONY COMMUNICATIONS SYSTEMS **c32**

Richard P. Dowling *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 7 p (For primary document see N93-27956 10-91)

Avail: CASI HC A02/MF A03

This paper addresses system aspects of communications for a lunar colony. Human factors are particularly noted. The practical aspects of communications infrastructure are emphasized rather than specific technologies. Communications needs for mission support and morale are discussed along with potential means of satisfying them. Problem areas are identified and some possible solutions are considered.

Author (revised)

N93-27984*# Boeing Defense and Space Group, Huntsville, AL.

REGOLITH THERMAL ENERGY STORAGE FOR LUNAR NIGHTTIME POWER **c44**

Brian Tillotson *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 8 p Previously announced in IAA as A91-52340 (For primary document see N93-27956 10-91)

Avail: CASI HC A02/MF A03

A scheme for providing nighttime electric power to a lunar base is described. This scheme stores thermal energy in a pile of regolith. Any such scheme must somehow improve on the poor thermal conductivity of lunar regolith in vacuum. Two previous schemes accomplish this by casting or melting the regolith. The scheme described here wraps the regolith in a gas-tight bag and introduces a light gas to enhance thermal conductivity. This allows the system to be assembled with less energy and equipment than schemes which require melting of regolith. A point design based on the new scheme is presented. Its mass from Earth compares favorably with the mass of a regenerative fuel cell of equal capacity.

Author (revised)

N93-27985*# Boeing Defense and Space Group, Huntsville, AL.

LUNAR BASE THERMAL MANAGEMENT/POWER SYSTEM ANALYSIS AND DESIGN **c54**

Jerry R. McGhee *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 12 p (For primary document see N93-27956 10-91)

Avail: CASI HC A03/MF A03

A compilation of several lunar surface thermal management and power system studies completed under contract and IR&D is presented. The work includes analysis and preliminary design of all major components of an integrated thermal management system, including loads determination, active internal acquisition and transport equipment, external transport systems (active and passive), passive insulation, solar shielding, and a range of lunar surface radiator concepts. Several computer codes were utilized in support of this study, including RADSIM to calculate radiation exchange factors and view factors, RADIATOR (developed in-house) for heat rejection system sizing and performance analysis over a lunar day, SURPWER for power system sizing, and CRYSTORE for cryogenic system performance predictions. Although much of the work was performed in support of lunar rover studies, any or all of the results can be applied to a range of surface applications. Output data include thermal loads summaries, subsystem performance data, mass, and volume estimates (where applicable), integrated and worst-case lunar day radiator size/mass and effective sink temperatures for several concepts (shielded and unshielded), and external transport system performance estimates for both single and two-phase (heat pumped) transport loops. Several advanced radiator concepts are presented, along with brief assessments of possible system benefits and potential drawbacks. System point designs are presented for several cases, executed in support of the contract and IR&D studies, although the parametric nature of the analysis is stressed to illustrate applicability of the analysis procedure to a wide variety of lunar surface systems. The reference configuration(s) derived from the various studies will be presented along with supporting criteria. A preliminary design will also be presented for the reference basing scenario, including qualitative data regarding TPS concerns and issues. Author (revised)

N93-27986*# New York Univ., New York.

RECTENNA THERMAL MODEL DEVELOPMENT **c31**

Murall Kadiramangalam, Adrian Alden (Communications Research Centre, Ottawa, Ontario.), and Daniel Speyer *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 13 p (For primary document see N93-27956 10-91)

Avail: CASI HC A03/MF A03

Deploying rectennas in space requires adapting existing designs developed for terrestrial applications to the space environment. One of the major issues in doing so is to understand the thermal performance of existing designs in the space environment. Toward that end, a 3D rectenna thermal model has been developed, which involves analyzing shorted

rectenna elements and finite size rectenna element arrays. A shorted rectenna element is a single element whose ends are connected together by a material of negligible thermal resistance. A shorted element is a good approximation to a central element of a large array. This model has been applied to Brown's 2.45 GHz rectenna design. Results indicate that Brown's rectenna requires redesign or some means of enhancing the heat dissipation in order for the diode temperature to be maintained below 200 C above an output power density of 620 W/sq.m. The model developed in this paper is very general and can be used for the analysis and design of any type of rectenna design of any frequency. Author (revised)

N93-27987*# New York Univ., New York.
CHOICE OF ANTENNA GEOMETRY FOR MICROWAVE POWER TRANSMISSION FROM SOLAR POWER SATELLITES c20
Seth D. Potter *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 9 p (For primary document see N93-27956 10-91)
Avail: CASI HC A02/MF A03

A comparison is made between square and circular transmitting antennas for solar power satellite microwave power transmission. It is seen that the exclusion zone around the rectenna needed to protect populations from microwaves is smaller for a circular antenna operating at 2.45 GHz than it is for a square antenna at that frequency. If the frequency is increased, the exclusion zone size remains the same for a square antenna, but becomes even smaller for a circular antenna. Peak beam intensity is the same for both antennas if the frequency and antenna area are equal. The circular antenna puts a somewhat greater amount of power in the main lobe and somewhat less in the side lobes. Since rain attenuation and atmospheric heating remain problems above 10 GHz, it is recommended that future solar power satellite work concentrate on circular transmitting antennas at frequencies of roughly 10 GHz. Author (revised)

N93-27988*# Creativision Consulting, Westwood, CA.
AI IN SPACE: PAST, PRESENT, AND POSSIBLE FUTURES c63
Donald D. Rose and Jonathan V. Post (Computer Futures, Inc., Altadena, CA.) *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium Feb. 1992 12 p (For primary document see N93-27956 10-91)
Avail: CASI HC A03/MF A03

While artificial intelligence (AI) has become increasingly present in recent space applications, new missions being planned will require even more incorporation of AI techniques. In this paper, we survey some of the progress made to date in implementing such programs, some current directions and issues, and speculate about the future of AI in space scenarios. We also provide examples of how thinkers from the realm of science fiction have envisioned AI's role in various aspects of space exploration. Author (revised)

N93-28035# Remote Sensing Technology Center, Tokyo (Japan).
UNMANNED LUNAR SURFACE EXPLORATION [MUJIN GETSUMEN TANSA]
Hajime Koshiishi and Natsuhiko Motomura *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 18 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

N93-28039# Institute for Future Technology, Tokyo (Japan).
RESEARCH ON LUNAR RESOURCES DEVELOPMENT AND THEIR UTILIZATION [TSUKI SHIGEN NO KAIHATSU RITOU NO KENKYUU]
Jun Suzuki *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 22 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

N93-28044# Tokyo Univ. (Japan). Faculty of Science.
SCIENCE MISSIONS FOR LUNAR RESOURCES EXPLORATION [TSUKI SHIGEN TANSA NO SAIENSU MISSHON NI TSUITE]
Hiroshi Takeda *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 8 p In JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A02/MF A06

N93-28045# National Space Development Agency, Ibaraki (Japan).
MARS EXPLORATION MISSION [KASEI TANSA MISSHON]
Kazuo Oota *In its* Future Space Activity Workshop: Lunar Base Workshop 1992 15 Jul. 1992 22 p In ENGLISH and JAPANESE (For primary document see N93-28014 10-12)
Avail: CASI HC A03/MF A06

92 SOLAR PHYSICS

Includes solar activity, solar flares, solar radiation and sunspots. For related information see *93 Space Radiation.*

N93-27029*# Lockheed Missiles and Space Co., Palo Alto, CA. Research Lab.
INVESTIGATION OF SOLAR ACTIVE REGIONS AT HIGH RESOLUTION BY BALLOON FLIGHTS OF THE SOLAR OPTICAL UNIVERSAL POLARIMETER, EXTENDED DEFINITION PHASE Final Report, May 1992 - May 1993
Theodore D. Tarbell May 1993 68 p
(Contract NAS8-39395)
(NASA-CR-192555; NAS 1.26:192555; LMSC/P073417) Avail: CASI HC A04/MF A01

Technical studies of the feasibility of balloon flights of the former Spacelab instrument, the Solar Optical Universal Polarimeter, with a modern charge-coupled device (CCD) camera, to study the structure and evolution of solar active regions at high resolution, are reviewed. In particular, different CCD cameras were used at ground-based solar observatories with the SOUP filter, to evaluate their performance and collect high resolution images. High resolution movies of the photosphere and chromosphere were successfully obtained using four different CCD cameras. Some of this data was collected in coordinated observations with the Yohkoh satellite during May-July, 1992, and they are being analyzed scientifically along with simultaneous X-ray observations. Author (revised)

N93-27078*# Massachusetts Inst. of Tech., Cambridge. Center for Space Research.
A LOW-MASS FARADAY CUP EXPERIMENT FOR THE SOLAR WIND
A. J. Lazarus, J. T. Steinberg, and R. L. McNutt, Jr. (Johns Hopkins Univ., Laurel, MD.) 1993 9 p
(Contract NAGw-1550; N00039-91-C-001)
(NASA-CR-193210; NAS 1.26:193210) Avail: CASI HC A02/MF A01

Faraday cups have proven to be very reliable and accurate instruments capable of making 3-D velocity distribution measurements on spinning or 3-axis stabilized spacecraft. Faraday cup instrumentation continues to be appropriate for heliospheric missions. As an example, the reductions in mass possible relative to the solar wind detection system about to be flown on the WIND spacecraft were estimated. Through the use of technology developed or used at the MIT Center for Space Research but were not able to utilize for WIND: surface-mount packaging, field-programmable gate arrays, an optically-switched high voltage supply, and an integrated-circuit power converter, it was estimated that the mass of the Faraday Cup system could be reduced from 5 kg to 1.8 kg. Further redesign of the electronics incorporating hybrid integrated circuits as well as a decrease in the sensor size, with a corresponding increase in measurement cycle time, could lead to a significantly lower mass for other mission applications. Reduction in mass of the entire spacecraft-experiment system is critically dependent on early and continual collaborative efforts between the spacecraft engineers and the experimenters. Those efforts concern a range of issues from spacecraft structure to data systems to the spacecraft power voltage levels. Requirements for flight qualification affect use of newer, lighter electronics packaging and its implementation; the issue of quality assurance needs to be specifically addressed. Lower cost and reduced mass can best be achieved through the efforts of a relatively small group dedicated to the success of the mission. Such a group needs a fixed budget and greater control over quality assurance requirements, together with a reasonable oversight mechanism. Author

N93-27114*# Stanford Univ., CA. Center for Space Science and Astrophysics.
PHYSICS OF SOLAR ACTIVITY Final Technical Report, 1971 - 1990

Peter A. Sturrock 1993 17 p
(Grant NGL-05-020-272)
(NASA-CR-193139; NAS 1.26:193139) Avail: CASI HC A03/MF A01

The aim of the research activity was to increase our understanding of solar activity through data analysis, theoretical analysis, and computer modeling. Because the research subjects were diverse and many researchers were supported by this grant, a select few key areas of research are described in detail. Areas of research include: (1) energy storage and force-free magnetic field; (2) energy release and particle acceleration; (3) radiation by nonthermal electrons; (4) coronal loops; (5) flare classification; (6) longitude distributions of flares; (7) periodicities detected in the solar activity; (8) coronal heating and related problems; and (9) plasma processes. Derived from text

N93-27513# National Geophysical Data Center, Boulder, CO.
SOLAR-GEOPHYSICAL DATA NUMBER 582, FEBRUARY 1993. PART 1: (PROMPT REPORTS). DATA FOR JANUARY 1993, DECEMBER 1992 AND LATE DATA
Helen E. Coffey, ed. Jan. 1993 112 p See also PB93-161743 and PB93-174043
(PB93-174035; SGD-582-Pt-1) Avail: CASI HC A06/MF A02

The contents are as follows: Detailed Index for 1992-1993; Data for January 1993; Solar-Terrestrial Environment; IUWDS Alert Periods (Advance and Worldwide); Solar Activity Indices; Solar Flares; Solar Radio Emission; Stanford Mean Solar Magnetic Field; Data for December 1992; Solar Active Regions; Sudden Ionospheric Disturbances; Solar Radio Spectral Observations; Cosmic Ray Measurements by Neutron Monitor; Geomagnetic Indices; and Principal Magnetic Storms. NTIS

N93-27514# National Geophysical Data Center, Boulder, CO.
SOLAR-GEOPHYSICAL DATA NUMBER 582, FEBRUARY 1993. PART 2: (COMPREHENSIVE REPORTS). DATA FOR AUGUST 1992 AND MISCELLANEOUS
Helen E. Coffey, ed. Feb. 1993 83 p See also PB93-161750 and PB93-174035
(PB93-174043; SGD-582-Pt-2) Avail: CASI HC A05/MF A01

The contents are as follows: Detailed Index for 1992-1993; Data for August 1992; Solar Flares; Solar Radio Bursts at Fixed Frequencies; Solar X-ray Radiation from GOES Satellite Graphs; Mass Ejections from the Sun; Active Prominences and Filaments; and IMP-8 Solar Wind Plot. NTIS

N93-27827# Yale Univ., New Haven, CT. Dept. of Astronomy.
DEVELOPMENT OF A SYSTEM FOR ACCURATE FORECASTING OF SOLAR ACTIVITY Annual Report, 15 Oct. 1991 - 14 Oct. 1992
Sabatino Sofia 1992 3 p
(Grant AF-AFOSR-0053-91)
(AD-A262450; AFOSR-93-0161TR) Avail: CASI HC A01/MF A01

Work on solar activity forecasting has concentrated on the search for correlations which would allow the forecast of a given cycle with an anticipation larger than 4 to 5 years. The work on solar dynamo modeling involved a formulation of a realistic model of magnetic diffusion. This work is essentially complete and is capable of handling reliably the small scale interaction between convection and magnetic fields. Significant progress has occurred in the Solar Disk Sextant work with the completion of the wedge fabricated by optical contact. A successful balloon flight has yielded 20 gigabytes of data for which reduction and analysis methods are being developed. DTIC

N93-28079 Arizona Univ., Tucson.
ULTRAVIOLET RESONANCE RADIATION AND THE STRUCTURE OF THE HELIOSPHERE Ph.D. Thesis
Doyle Thomas Hall 1992 244 p
Avail: Univ. Microfilms Order No. DA9307702

The solar system and heliosphere are embedded in a partially ionized medium flowing past the Sun at about 22 km/s. The Voyager and Pioneer 10 spacecraft are travelling upstream and downstream respectively, detecting Lyman alpha radiation resonantly scattered from heliospheric hydrogen. None of the probes has encountered the solar wind termination shock, where the supersonic solar wind is believed to decelerate to subsonic speeds. Penetration of H atoms from the local interstellar flow is the principal source of heliospheric H. Solar gravitation, radiation pressure, and ionization processes largely control the H distribution. However, the presence of the solar wind termination shock is predicted to have two additional effects. H-p charge exchange reactions occurring in the hot, post-shock solar wind plasma should both reduce the number of penetrating H atoms and create a population of suprathermal H atoms. Therefore, heliospheric Lyman alpha emission lines should be composed of narrow and wide components, which should be diagnostic of outer heliospheric structure. Previously unpublished Voyager Cruise Maneuver observations obtained between 15 and 40 AU reveal that upstream Lyman alpha intensities fall as r(exp -0.75+/-0.05). Beyond 15 AU downstream, Pioneer 10 Lyman alpha falls as r(exp -1.07+/-0.1). These trends cannot be simultaneously reproduced using models which do not include the termination shock. The Voyager data suggest an additional source of Lyman alpha in the upstream region beyond 40 AU. This may be due to suprathermal H gas and/or gradients in the H density, both predicted to be associated with the termination shock. A new method of estimating the heliospheric H density between the two Voyager spacecraft is introduced. The results are ambiguous and suffer due to the uncertainty in relative instrumental Lyman alpha sensitivities. Dissert. Abstr.

N93-28157# Lawrence Livermore National Lab., CA.
STATUS OF THE SOVIET-AMERICAN GALLIUM EXPERIMENT
O. L. Anosov (Academy of Sciences, USSR, Moscow.), E. L. Faizov (Academy of Sciences, USSR, Moscow.), V. N. Gavrin (Academy of Sciences, USSR, Moscow.), A. V. Kalikhov (Academy of Sciences, USSR, Moscow.), T. V. Knodel (Academy of Sciences, USSR, Moscow.), I. I. Knyshenko (Academy of Sciences, USSR, Moscow.), V. N. Kornoukhov (Academy of Sciences, USSR, Moscow.), I. N. Mirmov (Academy of Sciences, USSR, Moscow.), A. V. Ostrinsky (Academy of Sciences, USSR, Moscow.), and A. M. Pshukov (Academy of Sciences, USSR, Moscow.) et al 26 Jan. 1993 8 p
(Contract W-7405-eng-48)
(DE93-009067; UCRL-JC-113044) Avail: CASI HC A02/MF A01

A radiochemical Ga-71-Ge-71 experiment to determine the primary flux of neutrinos from the Sun began measurements of the solar neutrino flux at the Baksan Neutrino Observatory in 1990. The number of Ge-71 atoms extracted from 30 tons of gallium in 1990 and from 57 tons of gallium in 1991 was measured in twelve runs during the period of Jan. 1990 to Dec. 1991. The combined 1990 and 1991 data sets give a value of 58 + 17/-24(stat.) +/- 14 (syst.) SNU. This is to be compared with 132 SNU predicted by the Standard Solar Model. DOE

93 SPACE RADIATION

Includes cosmic radiation; and inner and outer earth's radiation belts.

For biological effects of radiation see *52 Aerospace Medicine.* For theory see *73 Nuclear and High-Energy Physics.*

N93-27106# Oak Ridge National Lab., TN.
THE RADIATION PROTECTION PROBLEMS OF HIGH ALTITUDE AND SPACE FLIGHT
R. J. M. Fry 1993 15 p Presented at the Workshop on Radiation Protection Toward the Turn of the Century, Paris, France, 11-13 Jan. 1993
(Contract DE-AC05-84OR-21400)
(DE93-008573; CONF-930181-1) Avail: CASI HC A03/MF A01

This paper considers the radiation environment in aircraft at high altitudes and spacecraft in low earth orbit and in deep space and the factors that influence the dose equivalents. Altitude, latitude and solar cycle are the major influences for flights below the radiation belts. In deep space, solar cycle and the occurrence of solar particle events are the factors of influence. The major radiation effects of concern are cancer and infertility in males. In high altitude aircraft the radiation consists mainly of protons and neutrons, with neutrons contributing about half the equivalent dose. The average dose rate at altitudes of transcontinental flights that approach the polar regions are greater by a factor of about 2.5 than on routes at low latitudes. Current estimates of doses to air crews suggest they are well within the ICRP (1990) recommended dose limits for radiation workers. DOE

99 GENERAL

N93-27041# Office of the White House Press Secretary, Washington, DC.
AERONAUTICS AND SPACE REPORT OF THE PRESIDENT: FISCAL YEAR 1992 ACTIVITIES
NASA 1993 112 p
Avail: CASI HC A06/MF A02

The annual Aeronautics and Space Report includes a comprehensive description of the programmed activities and the accomplishments of all agencies of the United States in the field of aeronautics and space activities during the preceding calendar year. This year's report was prepared on a fiscal year basis, which is consistent with the budgetary period now used in programs of the Federal Government. The following areas are covered: space launch activities; space science; space flight and space technology; space communications; aeronautical activities; studies of the planet earth; and other aeronautical and space activities. Derived from text

N93-27285*# National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.
CHRONOLOGY OF KSC AND KSC RELATED EVENTS FOR 1992 Annual Report
Ken Nail, Jr. Mar. 1993 283 p Prepared in cooperation with Edgerton, Germeshausen and Grier, Inc., Cocoa Beach, FL
(NASA-TM-107561; NAS 1.15:107561; KSC-KHR-17) Avail: CASI HC A13/MF A03

This chronology is published to fulfill the requirements of KMI 2700.1 to describe and document KSC's role in NASA's progress. Materials for this chronology were selected from a number of published sources. The document records KSC events of interest to historians and other researchers. Arrangement is by date of occurrence, though the source cited may be dated one or more days after the event. An index is included. Derived from text

N93-27399# National Inst. of Standards and Technology, Gaithersburg, MD. Chemical Science and Technology Lab.
CSTL TECHNICAL ACTIVITIES 1992
H. G. Semerjian and B. I. Diamondstone 1993 395 p
(PB93-173482; NISTIR-5111) Avail: CASI HC A17/MF A04

The expanded responsibilities the authors were given nearly five years ago in becoming the National Institute of Standards and Technology have provided the authors with a significant challenge. The authors were instructed to more directly couple the research with industrial needs in the United States, while continuing to provide: the national system of chemical and physical measurements, the fundamental research base for tomorrow's chemical science and technology, and a national reference laboratory to address critical problems related to public health and safety. With these goals in mind, the report contains research from the Biotechnology Division; Chemical Engineering Division; Chemical Kinetics and Thermodynamics Division; Inorganic Analytical Research Division; Organic Analytical Research Division; Process Measurements Division; Surface and Microanalysis Science Division; and Thermophysics Division. NTIS

N93-27424# National Inst. of Standards and Technology, Gaithersburg, MD. Standard Reference Data.
NIST STANDARD REFERENCE DATA PRODUCTS CATALOG, 1993 Final Special Publication
M. W. Chase and J. C. Sauerwein Jan. 1993 87 p See also PB92-181163
(PB93-173409; NIST/SP-782) Avail: CASI HC A05/MF A01

The National Institute of Standards and Technology's (NIST) Standard Reference Data Program provides reliable, well-documented data to scientists and engineers for use in technical problem-solving, research, and development. The catalog lists published data compilations and current databases in the Standard Reference Database Series. The edition of the catalog contains many new databases and updates current ones. These data compilations have been subdivided into eight categories. Prices and ordering information are located at the back of the document. NTIS

N93-28201# Technische Physische Dienst TNO-TH, Delft (Netherlands).
ACTIVITIES REPORT OF THE TECHNISCHE DIENST TNO-TU, DELFT (NETHERLANDS) Annual Report, 1991 [TECHNISCHE PHYSISCHE DIENST TNO-TU, DELFT. JAARVERSLAG 1991]
1991 44 p In DUTCH Original contains color illustrations
(ETN-93-93343) Avail: CASI HC A03/MF A01

Measuring, calculation, and design methods for noise reduction were developed. Several research activities were performed on the field of heat transfer and flow processes. Material production processes for glass and ceramics were developed. Optical instruments were developed for space research and optical inspection. Several instruments were developed with a view to cost reduction, process control, and safety. ESA

N93-28254*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
LDEF: 69 MONTHS IN SPACE. PART 3: SECOND POST-RETRIEVAL SYMPOSIUM
Arlene S. Levine, ed. Washington Apr. 1993 515 p Symposium held in San Diego, CA, 1-5 Jun. 1992; sponsored by NASA, Washington and AIAA Original contains color illustrations
(RTOP 506-48-91-11)
(NASA-CP-3194-Pt-3; L-17196-Pt-3; NAS 1.55:3194-Pt-3) Avail: CASI HC A22/MF A04; 2 functional color pages

Papers presented at the Second Long Duration Exposure Facility (LDEF) Post-Retrieval Symposium are included. The papers represent the data analysis of the 57 experiments flown on the LDEF. The experiments include materials, coatings, thermal systems, power and propulsion, science (cosmic ray, interstellar gas, heavy ions, micrometeoroid, etc.), electronics, optics, and life science. For individual titles, see N93-28255 through N93-28288.

N93-28255*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
LDEF MATERIALS OVERVIEW **c25**
Bland A. Stein *In its* LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 741-789 (For primary document see N93-28254 10-99)
Avail: CASI HC A03/MF A04; 2 functional color pages

The flight and retrieval of the National Aeronautics and Space Administration's Long Duration Exposure Facility (LDEF) provided an opportunity for the study of the low-Earth orbit (LEO) environment and long-duration space environmental effects (SEE) on materials that is unparalleled in the history of the U.S. Space Program. The 5-year, 9-month flight of LDEF greatly enhanced the potential value of all materials on LDEF to the international SEE community, compared to that of the original 1-year flight plan. The remarkable flight attitude stability of LDEF enables specific analyses of individual and combined effects of LEO environmental parameters on identical materials on the same space vehicle. NASA recognized this potential by forming the LDEF Space Environmental Effects on Materials Special Investigation Group (MSIG) to address the greatly expanded materials and LEO space environment analysis opportunities available in the LDEF structure, experiment trays, and corollary measurements so that the combined value of all LDEF materials data to current and future space missions will be addressed and documented. An overview of the interim LDEF materials findings of the principal investigators and the Materials Special Investigation Group is provided. These revelations are based on observations of LEO environmental effects on materials made in space during LDEF retrieval and during LDEF tray deintegration at the Kennedy Space Center, and on findings of approximately 1.5 years of laboratory analyses of LDEF materials by the LDEF materials scientists. These findings were extensively reviewed and discussed at the MSIG-sponsored LDEF Materials Workshop '91. The results are presented in a format that categorizes the revelations as 'clear findings' or 'obscure preliminary findings' (and progress toward their resolution), plus resultant needs for new space materials developments and ground simulation testing/analytical modeling, in seven categories: materials/environmental parameters and data bases; LDEF contamination; thermal control coatings and protective treatments; polymers and films; polymer-matrix composites; metals, ceramics, and optical materials; and systems-related materials. The utilization of LDEF materials data for future low-Earth orbit missions is also discussed, concentrating on Space Station Freedom. In general, the LDEF data is remarkably consistent; LDEF will provide a 'benchmark' for materials design data bases for satellites in low-Earth orbit. Some materials were

identified to be encouragingly resistant to LEO SEE for 5.8-years; other 'space qualified' materials displayed significant environmental degradation. General contamination levels on LDEF were low, but molecular contamination was widespread; LDEF offers an unprecedented opportunity to provide a unified perspective of unmanned LEO spacecraft contamination mechanisms. New material development requirements for long-term LEO missions were identified and current ground simulation testing methods/data for new, durable materials concepts can be validated with LDEF results. LDEF findings are already being integrated into the design of Space Station Freedom. Author (revised)

N93-28256*# Manchester Univ. (England). Dept. of Geology.
OXYGEN ISOTOPES IMPLANTED IN THE LDEF SPACECRAFT **c25**
J. M. Saxton, I. C. Lyon, E. Chatzitheodoridis, P. VanLierde (VG Isotech, Middlewich, England.), J. D. Gilmour, and G. Turner *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 791-796 (For primary document see N93-28254 10-99)
Avail: CASI HC A02/MF A04; 2 functional color pages

Secondary ion mass spectrometry was used to study oxygen implanted in the surface of copper from the Long Duration Exposure Facility (LDEF). Oxidation that occurred in orbit shows a characteristic oxygen isotope composition, depleted in O-18. The measured depletion is comparable to the predicted depletion (45 percent) based on a model of the gravitational separation of the oxygen isotopes. The anomalous oxygen was contained within 10nm of the surface. Tray E10 was calculated to have received 5.14 x 10(exp 21) atoms of oxygen cm(sup -2) during the LDEF mission and so there is sufficient anomalous implanted oxygen present in the surface to obtain a reliable isotopic profile. Author (revised)

N93-28257*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
SILAZINE TO SILICA **c25**
Gale A. Harvey *In its* LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 797-810 (For primary document see N93-28254 10-99)
Avail: CASI HC A03/MF A04; 2 functional color pages

Thin film silica and/or methyl silicone were detected on most external surfaces of the retrieved LDEF. Both solar ultraviolet radiation and atomic oxygen can convert silicones to silica. Known sources of silicone in or on the LDEF appear inadequate to explain the ubiquitous presence of the silica and silicone films. Hexamethyldisilazane (HMDS) was used as the Challenger tile waterproofing compound for the Challenger/LDEF deployment mission. HMDS is both volatile and chemically reactive at STP. In addition, HMDS releases NH3 which depolymerizes silicone RTV's. Polyurethanes are also depolymerized. Experiments are reported that indicate much of the silicone and silica contamination of LDEF resulted directly or indirectly from HMDS. Author (revised)

N93-28258*# LeTourneau Coll., Longview, TX.
STABILITY AND REACTIVITY OF DIMETHYLETHOXYSILANE **c25**
Richard E. Johnson and Douglas I. Ford *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 811-825 Sponsored by NASA. Johnson Space Center (For primary document see N93-28254 10-99)
Avail: CASI HC A03/MF A04; 2 functional color pages

The chemistry of the compound dimethylethoxysilane (DMES) is discussed especially as it relates to waterproofing silica surfaces. Some of the desirable properties of this compound are that it readily reacts with silica in the vapor phase, it is a low boiling point liquid (54 C), and the by-product of its reaction with silica is the rather inert substances ethanol. It is currently used by NASA to re-waterproof the HRSI shuttle tiles before relaunching the vehicle. Very little information is available on this particular compound in the literature or even on related silane compounds that have both a hydride group and an alkoxy group. Since the close proximity of two groups often drastically affects the chemical behavior of each group, chemical reactions were carried out in the laboratory with DMES to verify the expected behavior of these two functional groups located on DMES. Some of the reactions tested would be potentially useful for quantitative or qualitative measurements on DMES. To study the reactions of DMES with silica surfaces, cabosil was used as a silica substrate because of its high surface area and the ease of detection by infrared spectroscopy as well as other techniques. Author (revised)

N93-28259*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
LDEF POLYMERIC MATERIALS: 10 MONTHS VERSUS 5.8 YEARS OF EXPOSURE **c27**
Philip R. Young, Wayne S. Slemp, and Alice C. Chang (Lockheed Engineering and Sciences Co., Hampton, VA.) *In its* LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 827-847 (For primary document see N93-28254 10-99)
Avail: CASI HC A03/MF A04; 2 functional color pages

The chemical characterization of several polymeric materials which received 10 months of exposure and 5.8 years of exposure on a Row 9 Long Duration Exposure Facility (LDEF) experiment (A0134) is reported. Specimens include fluorinated ethylene propylene (FEP) teflon film, polysulfone film, and graphite fiber reinforced epoxy amd polysulfone matrix composites. The responses of these materials to the two LEO exposures are compared. The results of infrared, thermal, x-ray photoelectron, and scanning electron microscope analyses are reported. Solution property measurements of various molecular weight parameters are presented for the thermoplastic polysulfone materials. Molecular level effects attributable to exposure that were present in 10-month exposed specimens were not found in 5.8-year exposed specimens. This result suggests that increased atomic oxygen fluence toward the end of the LDEF mission may have eroded away selected environmentally induced changes in surface chemistry for 5.8-year exposure specimens. Author

N93-28260*# Texas A&M Univ., College Station. Polymer Technology Center.
VISCOELASTIC CHARACTERIZATION OF THIN-FILM POLYMERS EXPOSED TO LOW EARTH ORBIT **c27**
Alan Letton, Allan Farrow, and Thomas Strganac *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 849-866 Sponsored in part by Rheometrics, Inc. (For primary document see N93-28254 10-99)
Avail: CASI HC A03/MF A04; 2 functional color pages

The materials made available through the Long Duration Exposure Facility (LDEF) satellite provide a set of specimens that can be well characterized and have a known exposure history with reference to atomic oxygen and ultraviolet radiation exposure. Mechanical characteristics measured from control samples and exposed samples provide a data base for predicting the behavior of polymers in low earth orbit. Samples of 1.0 mil thick low density polyethylene were exposed to the low earth orbit environment for a period of six years. These materials were not directly exposed to ram atomic oxygen and offer a unique opportunity for measuring the effect of atomic oxygen and UV radiation on mechanical properties with little concern to the effect of erosion. The viscoelastic characteristics of these materials were measured and compared to the viscoelastic characteristics of control samples. To aid in differentiating the effects of changes in crystallinity resulting from thermal cycling, from the effects of changes in chemical structure resulting from atomic oxygen/UV attack to the polymer, a second set of control specimens, annealed to increase crystallinity, were measured as well. The resulting characterization of these materials will offer insight into the impact of atomic oxygen/UV on the mechanical properties of polymeric materials. The viscoelastic properties measured for the control, annealed, and exposed specimens were the storage and loss modulus as a function of frequency and temperature. From these datum is calculated the viscoelastic master curve derived using the principle of time/temperature superposition. Using the master curve, the relaxation modulus is calculated using the method of Ninomiya and Ferry. The viscoelastic master curve and the stress relaxation modulus provide a direct measure of the changes in the chemical or morphological structure. In addition, the effect of these changes on long-term and short-term mechanical properties is known directly. It should be noted that the dependence on directionality for the polymer films was considered since these films were manufactured by a blown-film process. Author (revised)

N93-28261*# Queensland Univ., Brisbane (Australia). Polymer Materials and Radiation Group.
A STUDY OF THE UV AND VUV DEGRADATION OF FEP **c27**
Graeme A. George, David J. T. Hill, James H. ODonnell, Peter J. Pomery,

and Firas A. Rasoul *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 867-876 (For primary document see N93-28254 10-99)
Avail: CASI HC A02/MF A04; 2 functional color pages

UV and VUV degradation of fluorinated ethylene propylene (FEP) copolymer was studied using electron spin resonance (ESR) spectroscopy, x-ray photoelectron spectroscopy (XPS), and scanning electron microscopy (SEM). The ESR study revealed the formation of a terminal polymer radical. The stability of this radical was investigated under different environments. An XPS study of FEP film exposed to VUV and atomic oxygen showed that oxidation takes place on the polymer surface. The study revealed also that the percentage of CF2 in the polymer surface decreased with exposure time and the percentage of CF, CF3, and carbon attached to oxygen increased. SEM micrographs of FEP film exposed to VUV and atomic oxygen identified a rough surface with undulations similar to sand dunes. Author (revised)

N93-28262*# Toronto Univ., North York (Ontario). Inst. for Aerospace Studies.
OUTGASSING AND DIMENSIONAL CHANGES OF POLYMER MATRIX COMPOSITES IN SPACE **c24**
R. C. Tennyson and R. Matthews *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 877-888 Sponsored in part by Canadian Space Agency; Inst. for Space and Terrestrial Science and Ontario Centre for Materials Research (For primary document see N93-28254 10-99)
Avail: CASI HC A03/MF A04; 2 functional color pages

A thermal-vacuum outgassing model and test protocol for predicting outgassing times and dimensional changes for polymer matrix composites is described. Experimental results derived from a 'control' sample are used to provide the basis for analytical predictions to compare with the outgassing response of Long Duration Exposure Facility (LDEF) flight samples. Author (revised)

N93-28263*# Michigan Univ., Ann Arbor.
HIGH-TOUGHNESS GRAPHITE/EPOXY COMPOSITE MATERIAL EXPERIMENT **c24**
David K. Felbeck *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 889-903 (For primary document see N93-28254 10-99)
(Contract NAS1-17008)
Avail: CASI HC A03/MF A04; 2 functional color pages

This experiment was designed to measure the effect of near-earth space exposure on three mechanical properties of specially toughened 5208/T300 graphite/epoxy composite materials. The properties measured are elastic modulus, strength, and fracture toughness. Six toughness specimens and nine tensile specimens were mounted on an external frame during the 5.8-year orbit of the Long Duration Exposure Facility (LDEF). Three identical sets of specimens were manufactured at the outset: the flight set, a zero-time non-flight set, and a total-time non-flight set. Author

N93-28264*# Phillips Lab., Kirtland AFB, NM. Space Environmental Interaction Branch.
LDEF FIBER-COMPOSITE MATERIALS CHARACTERIZATION **c24**
C. J. Miglionico, C. Stein, R. E. Roybal, and L. E. Murr (Texas Univ., El Paso.) *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 905-922 (For primary document see N93-28254 10-99)
(Grant NAG9-481)
Avail: CASI HC A03/MF A04; 2 functional color pages

Degradation of a number of fiber/polymer composites located on the leading and trailing surfaces of LDEF where the atomic oxygen (AO) fluences ranged from 10(exp 22) to 10(exp 4) atoms/cm(sup 2), respectively, was observed and compared. While matrices of the composites on the leading edge generally exhibited considerable degradation and erosion-induced fragmentation, this 'asking' process was confined to the near surface regions because these degraded structures acted as a 'protective blanket' for deeper-lying regions. This finding leads to the conclusion that simple surface coatings can significantly retard AO and other combinations of degrading phenomena in low-Earth orbit. Micrometeoroid and debris particle impacts were not a prominent feature on the fiber composites studied and apparently do not contribute in a significant way to their degradation or alteration in low-Earth orbit. Author (revised)

N93-28265*# Boeing Defense and Space Group, Seattle, WA.
SPACE ENVIRONMENTAL EFFECTS ON LDEF COMPOSITES: A LEADING EDGE COATED GRAPHITE EPOXY PANEL **c24**
Pete E. George, Harry W. Dursch, and Sylvester G. Hill *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 923-939 (For primary document see N93-28254 10-99)
Avail: CASI HC A03/MF A04; 2 functional color pages

The electronics module cover for the leading edge (Row D 9) experiment M0003-8 was fabricated from T300 graphite/934 epoxy unidirectional prepreg tape in a (O(sub 2), +/- 45, O(sub 2), +/- 45, 90, 0)(sub s) layup. This 11.75 in x 16.75 in panel was covered with thermal control coatings in three of the four quadrants with the fourth quadrant uncoated. The composite panel experienced different thermal cycling extremes in each quadrant due to the different optical properties of the coatings and bare composite. The panel also experienced ultraviolet (UV) and atomic oxygen (AO) attack as well as micrometeoroid and space debris impacts. An AO reactivity of 0.99 x 10(exp -24) cm(sup 3)/atom was calculated for the bare composite based on thickness loss. The white urethane thermal control coatings (A276 and BMS 1060) prevented AO attack of the composite substrate. However, the black urethane thermal control coating (Z306) was severely eroded by AO, allowing some AO attack of the composite substrate. An interesting banding pattern on the AO eroded bare composite surface was investigated and found to match the dimensions of the graphite fiber tow widths as prepregged. Also, erosion depths were greater in the darker bands. Five micrometeoroid/space debris impacts were cross sectioned to investigate possible structural damage as well as impact/AO interactions. Local crushing and delaminations were found to some extent in all of the impacts. No signs of coating undercutting were observed despite the extensive AO erosion patterns seen in the exposed composite material at the impact sites. An extensive microcrack study was performed on the panel along with modeling of the thermal environment to estimate temperature extremes and thermal shock. The white coated composite substrate displayed almost no microcracking while the black coated and bare composite showed extensive microcracking. Significant AO erosion was seen in many of the cracks in the bare composite. Author (revised)

N93-28266*# Rockwell International Corp., Tulsa, OK. North American Aircraft.
THE EFFECTS OF LONG-DURATION SPACE EXPOSURE ON THE MECHANICAL PROPERTIES OF SOME CARBON-REINFORCED RESIN MATRIX COMPOSITES **c24**
Richard F. Vyhnal *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 941-955 (For primary document see N93-28254 10-99)
Avail: CASI HC A03/MF A04; 2 functional color pages

Long Duration Exposure Facility (LDEF) Experiment A0175 involved the non-instrumented exposure of seven carbon-fiber reinforced resin-matrix advanced composite panels contained in two trays - A7 and A1. These two trays were located, respectively, on the leading and trailing faces of LDEF, obliquely oriented to the RAM (Row 9) and WAKE (Row 3) directions. The identity and location of the seven panels, which consisted of six flat laminates of the following material systems are shown: carbon/epoxy (T300/934), carbon/bismaleimide (T300/F178), and carbon/polyimide (C6000/LARC-160 and C6000/PMR-15), plus one bonded honeycomb sandwich panel (T300/934 face sheets and Nomex core) patterned after the Space Shuttle payload bay door construction. These material systems were selected to represent a range of then-available matrix resins which, by virtue of their differing polymer chemistry, could conceivably exhibit differing susceptibility to the low-earth orbit (LEO) environment. The principal exposure conditions of the LDEF environment at these tray locations are shown. Noteworthy to some of the observations discussed is the four-orders-of magnitude difference in the atomic oxygen (AO) fluence, which made a shallow incidence angle (approximately 22 deg) to Tray A7, while Tray A1 on the trailing face was essentially shielded from AO exposure. This evaluation focused on determining the individual and relative suitability of a variety of resin-matrix composite systems for long-term space structural applications. This was accomplished primarily by measuring and comparing a range of engineering mechanical properties on over 300 test coupons

sectioned from the flight panels and from identical control panels, and tested at ambient and elevated temperatures. This testing was supported by limited physical characterization, involving visual examination of flight panel surface features, measurements of weight loss and warpage, and examination for changes in internal integrity (micro cracking, delamination) by ultrasonic c-scan and polished cross-sections. Author

N93-28267*# Grumman Aerospace Corp., Bethpage, NY.
AN XPS STUDY OF SPACE-EXPOSED POLYIMIDE FILM **c27**
Myung Lee, William Rooney, and James Whiteside *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 957-962 (For primary document see N93-28254 10-99)
Avail: CASI HC A02/MF A04; 2 functional color pages

X-ray photoelectron spectroscopy was used to assess changes induced in the surface chemistry of Kapton H (Du Pont Trademark) polyimide strips exposed to the low Earth orbit environment at the space-end of the LDEF satellite on Experiment A0133. Results from flight specimens are compared to material cut from the same lot and stored at room temperature under standard atmospheric conditions. One notable difference was a nearly two-fold increase in surface oxygen (atom-percent composition) for specimens exposed to the direct space environment as compared to controls. In addition, space exposed specimens contained distinct silicon peaks (2p 103.2 eV and 2s 154.2 eV) in their spectra. These peaks were absent in control spectra. It is likely that the increase in oxygen is associated with the silicon. This is in agreement with reports of widespread silicon contamination throughout the LDEF satellite. Author

N93-28268*# Aerospace Corp., El Segundo, CA.
SURFACE ANALYSES OF COMPOSITES EXPOSED TO THE SPACE ENVIRONMENT ON LDEF **c24**
Joseph J. Mallon, Joseph C. Uht, and Carol S. Hemminger *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 963-976 (For primary document see N93-28254 10-99)
(Contract F04701-88-C-0089)
Avail: CASI HC A03/MF A04; 2 functional color pages

A series of surface analyses on carbon fiber/poly(arylacetylene) (PAA) matrix composites that were exposed to the space environment on the Long Duration Exposure Facility (LDEF) satellite were conducted. These composite panels were arranged in pairs on both the leading edge and trailing edge of LDEF. None of the composites were catastrophically damaged by nearly six years of exposure to the space environment. Composites on the leading edge exhibited from 25 to 125 microns of surface erosion, but trailing edge panels exhibited no physical appearance changes due to exposure. Scanning electron microscopy (SEM) was used to show that the erosion morphology on the leading edge samples was dominated by crevasses parallel to the fibers with triangular cross sections 10 to 100 microns in depth. The edges of the crevasses were well defined and penetrated through both matrix and fiber. The data suggest that the carbon fibers are playing an important role in crevasse initiation and/or enlargement, and in the overall erosion rate of the composite. X-ray photoelectron spectroscopy (XPS) and energy dispersive x-ray spectroscopy (EDS) results showed contamination from in-flight sources of silicone.
Author (revised)

N93-28269*# Aerospace Corp., Los Angeles, CA. Mechanics and Materials Technology Center.
THERMAL EXPANSION BEHAVIOR OF LDEF METAL MATRIX COMPOSITES **c24**
Tuyen D. Le and Gary L. Steckel *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 977-1000 (For primary document see N93-28254 10-99)
Avail: CASI HC A03/MF A04; 2 functional color pages

The thermal expansion behavior of Long Duration Exposure Facility (LDEF) metal matrix composite materials was studied by (1) analyzing the flight data that was recorded on orbit to determine the effects of orbital time and heating/cooling rates on the performance of the composite materials, and (2) characterizing and comparing the thermal expansion behavior of post-flight LDEF and lab-control samples. The flight data revealed that structures in space are subjected to nonuniform temperature distributions, and thermal conductivity of a material is an important factor in establishing a uniform temperature distribution and avoiding thermal distortion. The flight and laboratory data showed that both Gr/Al and Gr/Mg composites were stabilized after prolonged thermal cycling on orbit. However, Gr/Al composites showed more stable thermal expansion behavior than Gr/Mg composites and offer advantages for space structures particularly where very tight thermal stability requirements in addition to high material performance must be met. Author (revised)

N93-28270*# Sverdrup Technology, Inc., Arnold AFS, TN. Arnold Engineering Development Center Group.
SPECTRAL INFRARED HEMISPHERICAL REFLECTANCE MEASUREMENTS FOR LDEF TRAY CLAMPS **c74**
B. K. Cromwell, S. D. Shepherd (Air Force Systems Command, Arnold AFS, TN.), C. W. Pender, and B. E. Wood (Calspan Corp., Arnold AFS, TN.) *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 1001-1014 (For primary document see N93-28254 10-99)
Avail: CASI HC A03/MF A04; 2 functional color pages

Infrared hemispherical reflectance measurements that were made on 58 chromic acid anodized tray clamps from LDEF are described. The measurements were made using a hemiellipsoidal mirror reflectometer with interferometer for wavelengths between 2-15 microns. The tray clamps investigated were from locations about the entire spacecraft and provided the opportunity for comparing the effects of atomic oxygen at each location. Results indicate there was essentially no dependence on atomic oxygen fluence for the surfaces studied, but there did appear to be a slight dependence on solar radiation exposure. The reflectances of the front sides of the tray clamps consistently were slightly higher than for the protected rear tray clamp surfaces. Author (revised)

N93-28271*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
SURFACE CHARACTERIZATION OF SELECTED LDEF TRAY CLAMPS **c26**
T. F. Cromer (Virginia Polytechnic Inst. and State Univ., Blacksburg.), H. L. Grammer (Virginia Polytechnic Inst. and State Univ., Blacksburg.), J. P. Wightman (Virginia Polytechnic Inst. and State Univ., Blacksburg.), Philip R. Young, and Wayne S. Slemp *In its* LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 1015-1022 (For primary document see N93-28254 10-99)
(Grant NAG1-1186)
Avail: CASI HC A02/MF A04; 2 functional color pages

The surface characterization of chromic acid anodized 6061-T6 aluminum alloy tray clamps has shown differences in surface chemistry depending upon the position on the Long Duration Exposure Facility (LDEF). Water contact angle results showed no changes in wettability of the tray clamps. The overall surface topography of the control, trailing edge(E3) and leading edge(D9) samples was similar. The thickness of the aluminum oxide layer for all samples determined by Auger depth profiling was less than one micron. X-ray photoelectron spectroscopy (XPS) analysis of the tray clamps showed significant differences in the surface composition. Carbon and silicon containing compounds were the primary contaminants detected.
Author (revised)

N93-28272*# Boeing Defense and Space Group, Seattle, WA.
CONTAMINATION ON LDEF: SOURCES, DISTRIBUTION, AND HISTORY **c25**
Gary Pippin and Russ Crutcher *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 1023-1031 (For primary document see N93-28254 10-99)
(Contract NAS1-19247)
Avail: CASI HC A02/MF A04; 2 functional color pages

An introduction to contamination effects observed on the Long Duration Exposure Facility (LDEF) is presented. The activities reported are part of Boeing's obligation to the LDEF Materials Special Investigation Group. The contamination films and particles had minimal influence on the thermal performance of the LDEF. Some specific areas did have large changes in optical properties. Films also interfered with recession rate determination by reacting with the oxygen or physically shielding underlying material. Generally, contaminant films lessen the measured recession rate relative to 'clean' surfaces. On orbit generation of particles may be an issue for sensitive optics. Deposition on lenses may lead to artifacts on photographic

images or cause sensors to respond inappropriately. Particles in the line of sight of sensors can cause stray light to be scattered into sensors. Particles also represent a hazard for mechanisms in that they can physically block and/or increase friction or wear on moving surfaces. LDEF carried a rather complex mixture of samples and support hardware into orbit. The experiments were assembled under a variety of conditions and time constraints and stored for up to five years before launch. The structure itself was so large that it could not be baked after the interior was painted with chemglaze Z-306 polyurethane based black paint. Any analysis of the effects of molecular and particulate contamination must account for a complex array of sources, wide variation in processes over time, and extreme variation in environment from ground to launch to flight. Surface conditions at certain locations on LDEF were established by outgassing of molecular species from particular materials onto adjacent surfaces, followed by alteration of those species due to exposure to atomic oxygen and/or solar radiation. Author (revised)

N93-28273*# Aerospace Corp., El Segundo, CA.

CONTAMINATION MEASUREMENTS ON EXPERIMENT M0003 Abstract Only **c25**

Eugene N. Borson and F. Barry Sinsheimer *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 1033 (For primary document see N93-28254 10-99)

(Contract F04701-88-C-0089)

Avail: CASI HC A01/MF A04; 2 functional color pages

The contamination monitors on the M0003 experiment consisted of passive sample collectors to measure molecular and particulate deposition. The collectors were placed in the leading and trailing edge trays of M0003. The objective was to quantify the contaminants and determine how contamination affected the other materials in the trays. Duplicate collectors were placed inside the vacuum canisters that provided protection from the launch, ascent, deployment, and recovery environments. Analyses of the samples show small quantities of molecular deposition on both the leading and trailing edge trays. Silicone deposits are negligible. The aluminized fused silica, second surface mirrors showed small changes in solar absorptances. This is consistent with the small quantities of molecular deposits deduced from the FTIR measurements. The results of particle deposition, light scatter, and a micrometeoroid (or debris) impact are presented. Author (revised)

N93-28274*# TRW Electronic Systems Group, Redondo Beach, CA.

OPTICAL CHARACTERIZATION OF LDEF CONTAMINANT FILM **c74**

Brian K. Blakkolb, Lorraine E. Ryan, Howard S. Bowen (Hughes Aircraft Co., El Segundo, CA.), and Thomas J. Kosic (Hughes Aircraft Co., El Segundo, CA.) *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 1035-1040 (For primary document see N93-28254 10-99)

Avail: CASI HC A02/MF A04; 2 functional color pages

Dark brown molecular film deposits were found at numerous locations on the Long Duration Exposure Facility (LDEF) and have been documented in great detail by several investigators. The exact deposition mechanism for these deposits is as yet unknown, although direct and scattered atomic oxygen, and solar radiation interacting with materials outgassing products have all been implicated in the formation process. Specimens of the brown molecular film were taken from below the flange of the experimental tray located at position D10 on the LDEF. The tray was one of two, comprising the same experiment, the other being located on the wake facing side of the LDEF satellite at position B4. Having access to both trays, we were able to directly compare the effect that orientation with respect to the atomic oxygen flux vector had on the formation of the brown molecular film deposits. The film is thickest on surfaces facing toward the exterior, i.e. the tray corner, as can be seen by comparing the lee and wake aspects of the rivets. The patterns appear to be aligned not with the velocity vector but with the corner of the tray suggesting that flux to the surface is due to scattered atomic oxygen rather than direct ram impingement. The role of scattered flux is further supported by more faint plume patterns on the sides of the tray. The angle of these plumes is strongly aligned with the ram direction but the outline of the deposit implies that incident atoms are scattered by collisions with the edges of the opening resulting in a directed, but diffuse, flux of atomic oxygen to the surface. Spectral reflectance measurements in the 2 to 10 micron (4000 to 1000 wavenumbers) spectral range are presented for the film in the 'as deposited' condition and for the free standing film. The material was analyzed by FTIR (Fourier Transform Infrared) microspectroscopy using gold as the reference standard. The 'as deposited' specimen was on an aluminum rivet taken from beneath the tray flange while the free film was obtained by chipping some of the material from the rivet. The transmission spectrum over the 2 to 10 micron range for the free film is presented. This spectrum appears to be essentially the same as that presented by Crutcher et.al. for films formed at vent sites which faced into the ram direction and suggested to originate from urethanes and silicones used on the LDEF. Banks et. al. state that silicones, when exposed to atomic oxygen, release polymeric scission fragments which deposit on surfaces and form a glassy, dark contaminant layer upon further atomic oxygen exposure and solar irradiation. Author (revised)

N93-28275*# Boeing Defense and Space Group, Seattle, WA. Systems Special Investigation Group.

EVALUATION OF SEALS, LUBRICANTS, AND ADHESIVES USED ON LDEF **c27**

Harry Dursch, Bruce Keough, and Gary Pippin *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 1041-1060 (For primary document see N93-28254 10-99)

Avail: CASI HC A03/MF A04; 2 functional color pages

A wide variety of seals, lubricants, and adhesives were used on the Long Duration Exposure Facility (LDEF). The results, to date, of the Systems Special Investigation Group (SIG) and the Materials SIG investigation into the effect of the long term low Earth orbit (LEO) exposure on these materials is discussed. Results of this investigation show that if the material was shielded from exposure to LDEF's external environment, the 69 month exposure to LEO had minimal effect on the material. However, if the material was on LDEF's exterior surface, a variety of events occurred ranging from no material change, to changes in mechanical or physical properties, to complete disappearance of the material. The results are from the following sources: (1) visual examinations and/or testing of materials performed by various LDEF experimenters, (2) testing done at Boeing in support of the Materials or Systems SIG investigations, (3) testing done at Boeing on Boeing hardware flown on LDEF. Author (revised)

N93-28276*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

THE CONTINUING MATERIALS ANALYSIS OF THE THERMAL CONTROL SURFACES EXPERIMENT (S0069) **c27**

Donald R. Wilkes (AZ Technology, Huntsville, AL.), Edgar R. Miller (AZ Technology, Huntsville, AL.), James M. Zwiener, and Richard J. Mell *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 1061-1073 (For primary document see N93-28254 10-99)

Avail: CASI HC A03/MF A04; 2 functional color pages

The long term effects of the natural and induced space environment on spacecraft surfaces are critically important to future spacecraft - including Space Station Freedom. The damaging constituents of this environment include thermal vacuum, solar ultraviolet radiation, atomic oxygen, particulate radiation, and the spacecraft induced environment. The behavior of materials and coatings in the space environment continues to be a limiting technology for spacecraft and experiments. The Thermal Control Surfaces Experiment (TCSE) was flown on the National Aeronautics and Space Administration (NASA) Long Duration Exposure Facility (LDEF) to study these environmental effects on surfaces-particularly on thermal control surfaces. The TCSE was a comprehensive experiment that combined in-space measurements with extensive pre- and post-flight analyses of thermal control surfaces to determine the effects of exposure to the low Earth orbit space environment. The TCSE is the first space experiment to directly measure the total hemispherical reflectance of thermal control surfaces in the same way they are routinely measured in the laboratory. The trend analyses of selected coatings performed as part of the continuing post-flight analysis of the TCSE are described. A brief description of the TCSE and its mission on LDEF are presented. There are several publications available that describe the TCSE, it's mission on LDEF, and initial results in greater detail. These are listed in the TCSE Bibliography. Author (revised)

N93-28277*# Aerospace Corp., El Segundo, CA. Mechanics and Materials Technology Center.

THERMAL CONTROL PAINTS ON LDEF: RESULTS OF M0003 SUB-EXPERIMENT 18 **c27**

C. H. Jaggers, M. J. Meshishnek, and J. M. Coggi *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 1075-1092 Sponsored in part by Wright Lab. (For primary document see N93-28254 10-99)

Avail: CASI HC A03/MF A04; 2 functional color pages

Several thermal control paints were flown on the Long Duration Exposure Facility (LDEF), including the white paints Chemglaze A276, S13GLO, and YB-71, and the black paint D-111. The effects of low earth orbit, which includes those induced by UV radiation and atomic oxygen, varied significantly with each paint and its location on LDEF. For example, samples of Chemglaze A276 located on the trailing edge of LDEF darkened significantly due to UV-induced degradation of the paint's binder, while leading edge samples remained white but exhibited severe atomic oxygen erosion of the binder. Although the response of S13GLO to low earth orbit is much more complicated, it also exhibited greater darkening on trailing edge samples as compared to leading edge samples. In contrast, YB-71 and D-111 remained relatively stable and showed minimal degradation. The performance of these paints as determined by changes in their optical and physical properties, including solar absorptance as well as surface chemical changes and changes in surface morphology is examined. It will also provide a correlation of these optical and physical property changes to the physical phenomena that occurred in these materials during the LDEF mission. Author (revised)

N93-28278*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

LDEF THERMAL CONTROL COATINGS POST-FLIGHT ANALYSIS **c27**

Wayne S. Slemp and Philip R. Young *In its* LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 1093-1097 (For primary document see N93-28254 10-99)

Avail: CASI HC A01/MF A04; 2 functional color pages

The NASA Long Duration Exposure Facility (LDEF) provided a unique flight opportunity for conducting experiments in space and return of these experiments to Earth for laboratory evaluation. The results of one of these experiments, S0010, Exposure of Spacecraft Coatings, in which selected spacecraft thermal control coatings were exposed to the low-Earth orbital (LEO) environment on LDEF are reported. The objective of the experiment is to evaluate the response of thermal control coatings to LEO exposure, which includes atomic oxygen, ultraviolet and particulate radiation, meteoroid and debris, vacuum, and temperature cycling. Author (revised)

N93-28279*# Boeing Defense and Space Group, Seattle, WA.

SELECTED RESULTS FOR LDEF THERMAL CONTROL COATINGS **c27**

Johnny L. Golden *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 1099-1110 (For primary document see N93-28254 10-99)

Avail: CASI HC A03/MF A04; 2 functional color pages

Several different thermal control coatings were analyzed as part of the Long Duration Exposure Facility (LDEF) Materials Special Investigation Group activity and as part of the Space Environment Effects on Spacecraft Materials Experiment M0003. A brief discussion of the results obtained for these materials is presented. Author (revised)

N93-28280*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

FLUORESCENCE MEASUREMENTS OF THE THERMAL CONTROL EXPERIMENTS COATINGS ON LDEF S0069 AND A0114 **c27**

J. M. Zwiener, R. J. Mell, P. N. Peters, J. C. Gregory (Alabama Univ., Huntsville.), D. R. Wilkes (AZ Technology, Huntsville, AL.), and E. R. Miller (AZ Technology, Huntsville, AL.) *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 1111-1123 (For primary document see N93-28254 10-99)

Avail: CASI HC A03/MF A04; 2 functional color pages

Fluorescence measurements were made on the thermal control coatings from the Long Duration Experiment Facility (LDEF) S0069, Thermal Control Surfaces Experiment (TCSE); and the A0114, Interaction of Atomic Oxygen with Material Surfaces in Low Earth orbit. Fluorescence was observed in two types of thermal control coatings and is attributed to pigments or binders. In addition, fluorescence measurement on the silver Teflon from the front cover of TCSE led to confirmation of damage (cracking) to the metal layers during application. Author (revised)

N93-28281*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

ATOMIC OXYGEN EFFECTS ON LDEF EXPERIMENT AO171 **c72**

Ann F. Whitaker, Rachel R. Kamenetzky, Miria M. Finckenor, and Joseph K. Norwood *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 1125-1135 (For primary document see N93-28254 10-99)

Avail: CASI HC A03/MF A04; 2 functional color pages

The Solar Array Materials Passive Long Duration Exposure Facility (LDEF) Experiment (SAMPLE), AO171, contained in total approximately 100 materials and materials processes with a 300 specimen complement. With the exception of experiment solar cell and solar cell modules, all test specimens were weighed before flight, thus allowing an accurate determination of mass loss as a result of space exposure. Since almost all of the test specimens were thermal vacuum baked before flight, the mass loss sustained can be attributed principally to atomic oxygen attack. The atomic oxygen effects observed and measured in five classes of materials is documented. The atomic oxygen reactivity values generated for these materials are compared to those values derived for the same materials from exposures on short term shuttle flights. An assessment of the utility of predicting long term atomic oxygen effects from short term exposures is given. This experiment was located on Row 8 position A which allowed all experiment materials to be exposed to an atomic oxygen fluence of 6.93 x 10(exp 21) atoms/cm(sup 2) as a result of being positioned 38 degrees off the RAM direction. Author (revised)

N93-28282*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

MONTE CARLO MODELING OF ATOMIC OXYGEN ATTACK OF POLYMERS WITH PROTECTIVE COATINGS ON LDEF **c27**

Bruce A. Banks, Kim K. deGroh, Bruce M. Auer, Linda Gebauer (Cleveland State Univ., OH.), and Jonathan L. Edwards (Cleveland State Univ., OH.) *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 1137-1150 (For primary document see N93-28254 10-99)

Avail: CASI HC A03/MF A04; 2 functional color pages

Characterization of the behavior of atomic oxygen interaction with materials on the Long Duration Exposure Facility (LDEF) assists in understanding of the mechanisms involved. Thus the reliability of predicting in-space durability of materials based on ground laboratory testing should be improved. A computational model which simulates atomic oxygen interaction with protected polymers was developed using Monte Carlo techniques. Through the use of an assumed mechanistic behavior of atomic oxygen interaction based on in-space atomic oxygen erosion of unprotected polymers and ground laboratory atomic oxygen interaction with protected polymers, prediction of atomic oxygen interaction with protected polymers on LDEF was accomplished. However, the results of these predictions are not consistent with the observed LDEF results at defect sites in protected polymers. Improved agreement between observed LDEF results and predicted Monte Carlo modeling can be achieved by modifying of the atomic oxygen interactive assumptions used in the model. LDEF atomic oxygen undercutting results, modeling assumptions, and implications are presented. Author

N93-28283*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

SECOND LDEF POST-RETRIEVAL SYMPOSIUM INTERIM RESULTS OF EXPERIMENT A0034 **c27**

Roger C. Linton and Rachel R. Kamenetzky *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 1151-1168 (For primary document see N93-28254 10-99)

Avail: CASI HC A03/MF A04; 2 functional color pages

Thermal control coatings and contaminant collector mirrors were exposed on the leading and trailing edge modules of Long Duration Exposure Facility (LDEF) experiment A0034 to provide a basis of comparison for investigating the role of atomic oxygen in the stimulation of volatile outgassing products.

The exposure of identical thermal ccatings on both the leading and trailing edges of the LDEF and the additional modified exposure of identical coatings under glass windows and metallic covers in each of the flight modules provided multiple combinations of space environmental exposure to the coatings and the contaminant collector mirrors. Investigations were made to evaluate the effects of the natural space and the induced environments on the thermal coatings and the collector mirrors to differentiate the sources of observed material degradation. Two identical flight units were fabricated for the LDEF mission, each of which included twenty-five thermal control coatings mounted in isolated compartments, each with an adjacent contaminant collector mirror mounted on the wall. The covers of the flight units included apertures for each compartment, exposing the thermal coatings directly to the space environment. Six of these compartments were sealed with ultraviolet-grade transmitting quartz windows and four other compartments were sealed with aluminum covers. One module of this passive LDEF experiment, occupying one-sixth of a full tray, was mounted in Tray C9 (leading edge), while the other identical module was mounted in Tray C3 (trailing edge). Author (revised)

N93-28284*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

THE INTERACTION OF ATOMIC OXYGEN WITH COPPER: AN XPS, AES, XRD, OPTICAL TRANSMISSION, AND STYLUS PROFILOMETRY STUDY **c74**

Ganesh N. Raikar (Alabama Univ., Huntsville.), John C. Gregory (Alabama Univ., Huntsville.), Ligia C. Christl (Alabama Univ., Huntsville.), and Palmer N. Peters *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 1169-1186 (For primary document see N93-28254 10-99)

Avail: CASI HC A03/MF A04; 2 functional color pages

The University of Alabama in Huntsville (UAH) experiment A-0114 was designed to study the reaction of material surfaces with low earth orbits (LEO) atmospheric oxygen. The experiment contained 128 one-inch circular samples; metals, polymers, carbons, and semiconductors. Half of these samples were exposed on the front of the Long Duration Exposure Facility (LDEF) and remaining on the rear. Among metal samples, copper has shown some interesting new results. There were two forms of copper samples: a thin film sputter-coated on fused silica and a solid piece of OFHC copper. They were characterized by x-ray and Auger electron spectroscopies, x-ray diffraction, and high resolution profilometry. Cu 2p core level spectra were used to demonstrate the presence of Cu2O and CuO and to determine the oxidation states. Author (revised)

N93-28285*# Boeing Defense and Space Group, Seattle, WA.

LDEF MATERIALS DATA ANALYSIS: REPRESENTATIVE EXAMPLES **c25**

Gary Pippin and Russ Crutcher *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 1187-1199 (For primary document see N93-28254 10-99) (Contract NAS1-19247)

Avail: CASI HC A03/MF A04; 2 functional color pages

Part of the philosophy which guided the examination of hardware from the Long Duration Exposure Facility (LDEF) was that materials present at multiple locations should have fairly high priority for investigation. Properties of such materials were characterized as a function of exposure conditions to obtain as much data as possible for predicting performance lifetimes. Results from examination of several materials from interior locations of LDEF, selected measurements on silverized teflon blanket specimens, and detailed measurements on the copper grounding strap from tray D11 are summarized. Visual observations of interior locations of LDEF made during deintegration at KSC showed apparent changes in particular specimens. This inspection lead to testing of selected nylon clamps, fiberglass shims, and heat shrink tubing from wire harness clamps, and visually discolored silver coated hex nuts. Author (revised)

N93-28286*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

MATERIALS AND PROCESSES TECHNICAL INFORMATION SYSTEM (MAPTIS) LDEF MATERIALS DATA BASE **c82**

Joan G. Funk, John W. Strickland (BAMSI, Inc., Huntsville, AL.), and John M. Davis (National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.) *In its* LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 1201-1222 (For primary document see N93-28254 10-99)

Avail: CASI HC A03/MF A04; 2 functional color pages

A preliminary Long Duration Exposure Facility (LDEF) Materials Data Base was developed by the LDEF Materials Special Investigation Group (MSIG). The LDEF Materials Data Base is envisioned to eventually contain the wide variety and vast quantity of materials data generated from LDEF. The data is searchable by optical, thermal, and mechanical properties, exposure parameters (such as atomic oxygen flux) and author(s) or principal investigator(s). Tne LDEF Materials Data Base was incorporated into the Materials and Processes Technical Information System (MAPTIS). MAPTIS is a collection of materials data which has been computerized and is available to engineers, designers, and researchers in the aerospace community involved in the design and development of spacecraft and related hardware. The LDEF Materials Data Base is described and step-by-step example searches using the data base are included. Information on how to become an authorized user of the system is included.

Author (revised)

N93-28287*# Boeing Defense and Space Group, Seattle, WA.

DATA BASES FOR LDEF RESULTS **c82**

Gail Bohnhoff-Hlavacek *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 1223-1233 (For primary document see N93-28254 10-99) (Contract NAS1-19247)

Avail: CASI HC A03/MF A04; 2 functional color pages

The Long Duration Exposure Facility (LDEF) carried 57 experiments and 10,000 specimens for some 200 LDEF experiment investigators. The external surface of LDEF had a large variety of materials exposed to the space environment which were tested preflight, during flight, and post flight. Thermal blankets, optical materials, thermal control paints, aluminum, and composites are among the materials flown. The investigations have produced an abundance of analysis results. One of the responsibilities of the Boeing Support Contract, Materials and Systems Special Investigation Group, is to collate and compile that information into an organized fashion. The databases developed at Boeing to accomplish this task is described.

Author (revised)

N93-28288*# Aerospace Corp., El Segundo, CA.

LONG DURATION EXPOSURE FACILITY EXPERIMENT M0003 DEINTEGRATION OBSERVATION DATA BASE **c82**

S. R. Gyetvay, J. M. Coggi, and M. J. Meshishnek *In* NASA. Langley Research Center, LDEF: 69 Months in Space. Part 3: Second Post-Retrieval Symposium Apr. 1993 p 1235-1246 (For primary document see N93-28254 10-99)

Avail: CASI HC A03/MF A04; 2 functional color pages

The four trays (2 leading edge and 2 trailing edge) of the M0003 materials experiment on the Long Duration Exposure Facility (LDEF) contained 1274 samples from 20 subexperiments. The complete sample complement represented a broad range of materials, including thin film optical coatings, paints, polymer sheets and tapes, adhesives, and composites, for use in various spacecraft applications, including thermal control, structures, optics, and solar power. Most subexperiments contained sets of samples exposed on both the leading and trailing edge trays of LDEF. Each individual sample was examined by high resolution optical microscope during the deintegration of the subexperiments from the M0003 trays. Observations of the post-flight condition of the samples made during this examination were recorded in a computer data base. The deintegration observation data base is available to requesters on floppy disk in 4th Dimension for the Macintosh format. Over 3,000 color macrographs and photomicrographs were shot to complement the observation records and to document the condition of the individual samples and of the M0003 trays. The photographs provide a visual comparison of the response of materials in leading and trailing edge LDEF environments. The Aerospace Corporate Archives is distributing photographs of the samples and hard copies of the database records to the general public upon request. Information on obtaining copies of the data base disks and for ordering photographs and records of specific samples or materials are given.

Author (revised)

N93-28317# Netherlands Organization for Applied Scientific Research TNO, Delft.

ACTIVITIES REPORT OF THE NETHERLANDS ORGANIZATION FOR APPLIED SCIENTIFIC RESEARCH (TNO) Annual Report, 1991 [TNO-DEFENSIEONDERZOEK. JAAROVERZICHT 1991]

J. Boogaard, T. M. Groothuizen, G. vandeSchootbrugge, W. L. Smith, and G. A. Willemsem 1991 35 p In DUTCH

(ETN-93-93339) Avail: CASI HC A03/MF A01

The Prins Maurits Laboratory performed research in the fields of evacuation of ammunition on aircrafts, processing of explosives, simulation of the pretreatment of poisoning by the nervous gas soman, applications of activated carbon, and erosion free electromagentic launching. The Institute of Sensory Physiology carried out research in the fields of ergonomics and steerability of vehicles, prediction of heat tolerance, and geographic information systems from an ergonomic point of view. The Physics and Electronics Laboratory performed research activities in the fields of GaAs monolithic microwave integrated circuits, the Force Structure Study Facility, the registration of movements for zoning at airbase level, destruction of missiles for frigates, a Stinger trainer, the calibration of validation of the ERS-1 satellite, IR camera development, and a tactical communication system. ESA

N93-28334# Illinois Univ., Urbana. Materials Research Lab.

[DESCRIPTION AND PROGRAM ACTIVITIES OF THE MATERIALS RESEARCH LABORATORY] Progress Report, FY 1993

H. K. Birnbaum Mar. 1993 191 p

(Contract DE-FG02-91ER-45439)

(DE93-010905; DOE/ER-45439/178) Avail: CASI HC A09/MF A02

The materials research laboratory program is about 30% of total Materials Science and Engineering effort on the Univ. of Illinois campus. Coordinated efforts are being carried out in areas of structural ceramics, grain boundaries, field responsive polymeric and organic materials, molecular structure of solid-liquid interfaces and its relation to corrosion, and x-ray scattering science. DOE

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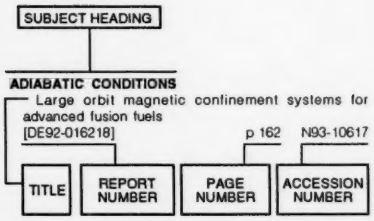

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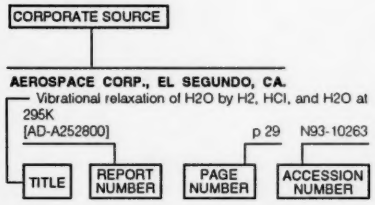

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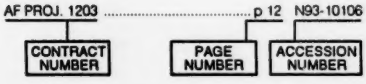

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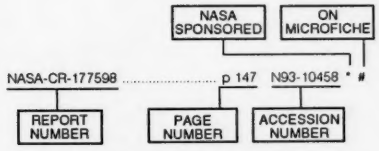

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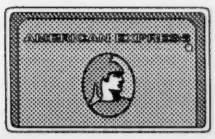

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ILLINOIS STATE LIBRARY
Reference Dept.
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(217) 782-7596 Fax: (217) 524-0041

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INDIANA STATE LIBRARY
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Iowa City, IA 52242
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KANSAS

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Govt. Documents & Map Library
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Lawrence, KS 66045-2800
(913) 864-4660 Fax: (913) 864-5380

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UNIV. OF KENTUCKY LIBRARIES
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Middleton Library
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Baton Rouge, LA 70803
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LOUISIANA TECHNICAL UNIV.
Prescott Memorial Library
Govt. Documents Dept.
305 Wisteria Street
Ruston, LA 71270-9985
(318) 257-4962 Fax: (318) 257-2447

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TRI-STATE DOCUMENTS DEPOS.
Raymond H. Fogler Library
Govt. Documents & Microforms Dept.
Univ. of Maine
Orono, ME 04469
(207) 581-1680

MARYLAND

UNIV. OF MARYLAND
Hornbake Library
Govt. Documents/Maps Unit
College Park, MD 20742
(301) 454-3034 Fax: (301) 454-4985

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BOSTON PUBLIC LIBRARY
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Wilson Library
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Minneapolis, MN 55455
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UNIV. OF MISSISSIPPI
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University, MS 38677
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(406)243-6700 Fax: (406) 243-2060

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Reno, NV 89557
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General Library
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Albuquerque, NM 87131-1466
(505) 277-5441 Fax: (505) 277-6019

NEW MEXICO STATE LIBRARY
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Santa Fe, NM 87503
(505) 827-3826 Fax: (505) 827-3820

NEW YORK

NEW YORK STATE LIBRARY
Documents/Gift & Exchange Section
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Cultural Education Center
Albany, NY 12230
(518) 474-5563 Fax: (518) 474-5786

NORTH CAROLINA

UNIV. OF NORTH CAROLINA - CHAPEL HILL
CB#3912, Davis Library
BA/SS Dept. - Documents
Chapel Hill, NC 27599
(919) 962-1151 Fax: (919) 962-0484

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NORTH DAKOTA STATE UNIV. LIB.
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STATE LIBRARY OF OHIO
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Columbus, OH 43266
(614) 644-7051 Fax: (614) 752-9178

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OKLAHOMA DEPT. OF LIBRARIES
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Oklahoma City, OK 73105-3298
(405) 521-2502, ext. 252, 253
Fax: (405) 525-7804

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Edmon Low Library
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Stillwater, OK 74078
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Millar Library
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Portland, OR 97207
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(717) 787-3752

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Cooper Library
Public Documents Unit
Clemson, SC 29634-3001
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In cooperation with Univ. of South Carolina, Thomas Cooper Library, Columbia

TENNESSEE

MEMPHIS STATE UNIV. LIBRARIES
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Memphis, TN 38152
(901) 678-2586 Fax: (901) 678-2511

TEXAS

TEXAS STATE LIBRARY
United States Documents
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Austin, TX 78711
(512) 463-5455 Fax: (512) 463-5436

TEXAS TECH. UNIV. LIBRARY
Documents Dept.
Lubbock, TX 79409
(806) 742-2268 Fax: (806) 742-1920

UTAH

UTAH STATE UNIV.
Merrill Library & Learning Resources Center, UMC-3000
Documents Dept.
Logan, UT 84322-3000
(801) 750-2684 Fax: (801) 750-2677

VIRGINIA

UNIV. OF VIRGINIA
Alderrman Library
Govt. Documents
Charlottesville, VA 22903-2498
(804) 824-3133 Fax: (804) 924-4337

WASHINGTON

WASHINGTON STATE LIBRARY
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Olympia, WA 98504-0111
(206) 753-4027 Fax: (206) 753-3546

WEST VIRGINIA

WEST VIRGINIA UNIV. LIBRARY
Govt. Documents Section
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Morgantown, WV 26506
(304) 293-3640

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